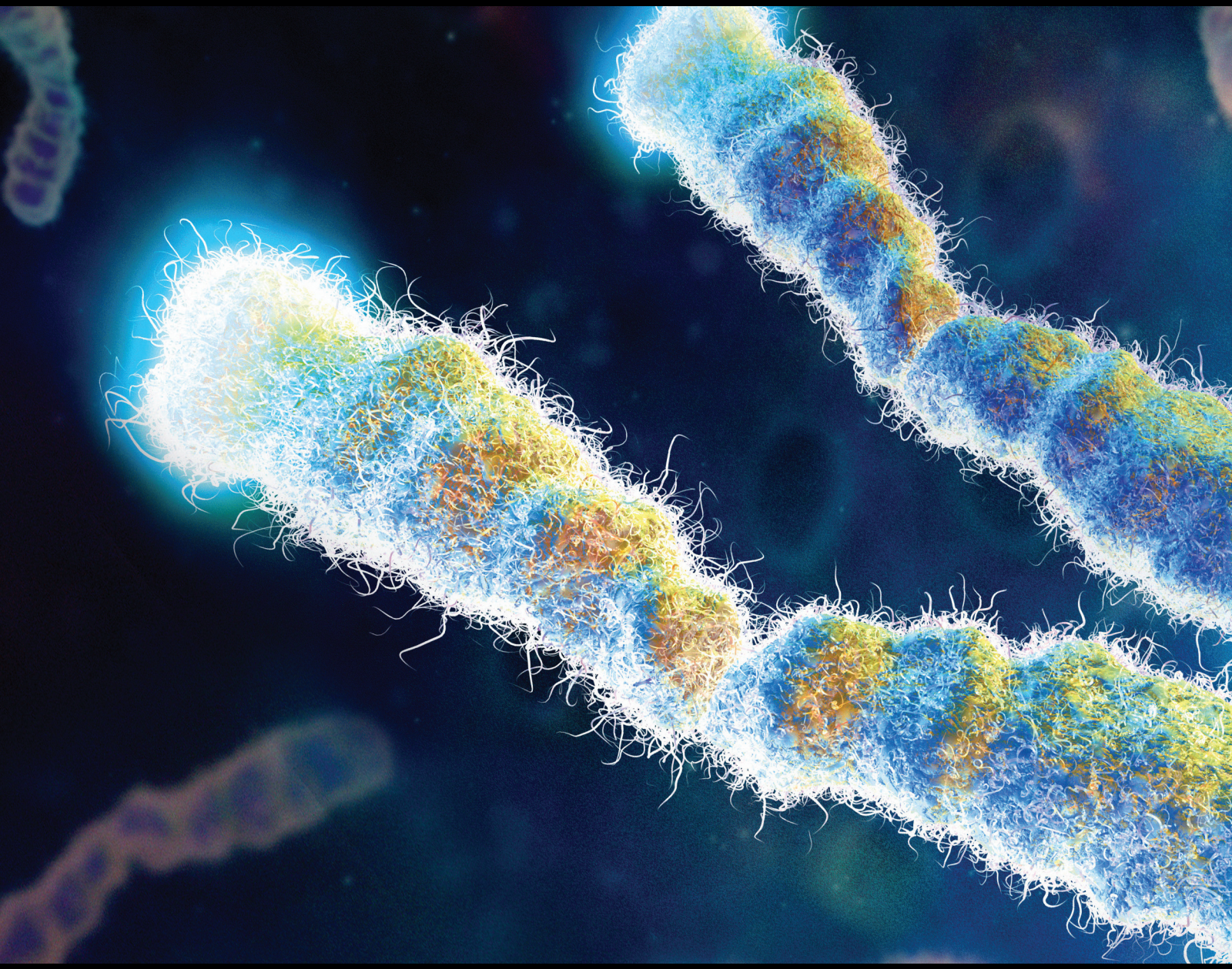
Journal of Aging Research

Active and Healthy Ageing and Independent Living

Guest Editors: Maddalena Illario, Miriam Vollenbroek-Hutten, David William Molloy, Enrica Menditto, Guido Iaccarino, and Patrik Eklund



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Editorial

Active and Healthy Ageing and Independent Living

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The recent economic crisis and the current epidemiological trends of Western populations highlighted how the current healthcare systems are inadequate to respond to the evolution of population needs. Among the most important societal challenges is aging, which often is associated with frailty, chronic diseases, and increased multimorbidity. The future costs of an aging society will not be sustainable in terms of healthcare and social services, unless they are reorganized with a focus on prevention and health promotion, in an integrated system. Innovation will be the driver able to turn a burden into an opportunity.

This special issue provides examples of innovative, cross-sectorial strategies that contribute directly or indirectly to improving the quality of life for older adults and their closer ones, making our health and social care systems more effecient and sustainable.

The relevance of connecting leisure time and lifestyle changes is highlighted by two contributions to the issue. Leisure engagement tends to decline with old age, and both articles point out the need for motivational drives to stimulate it. In particular, their evidences suggest that encouraging sedentary and inactive older adults, particularly those over age 65, to maintain or increase their overall daily activity, perhaps simply by reducing time spent in sedentary behaviors, has an even greater impact on reducing the demand for health services.

In the article "Is Self-Reported Physical Activity Participation Associated with Lower Health Services Utilization among Older Adults? Cross-Sectional Evidence from the Canadian Community Health Survey," the authors examined the relationships between leisure-time physical activity (LTPA) and health services utilization (HSU), in a nationally representative sample of community-dwelling older adults. Active 50–65-year-old individuals were 27% less likely to report any GP consultations and had 8% fewer GP consultations, annually, than their inactive peers. Active persons aged 65–79 years, were 18% less likely than inactive respondents to have been hospitalized overnight, in the previous year. Higher levels of LTPA were significantly associated with lower levels of HSU, across all age groups. In conclusion nonleisure PA appeared to be a stronger predictor of all types of HSU, particularly in the two oldest age groups. Focused strategies to reduce the time spent in sedentary activities may have a positive impact on reducing the demand for health services.

Furthermore, increasing health literacy contributes to a more proactive approach on patient's own health conditions and influences the engagement in leisure activities. Supports and barriers in the social, physical, or societal environment could, for example, be a part of interventions but are also shown to influence physical activities and are suggested to be used as predicting factors.

The aim of the review article "Leisure Engagement: Medical Conditions, Mobility Difficulties, and Activity Limitations—A Later Life Perspective" was to investigate the impact of medical conditions, mobility difficulties, and activity limitations on older people's engagement in leisure activities. The most important predictor of leisure engagement abstention, among older people, is the prevalence of activity limitations, whereas mobility difficulties and medical conditions play less important roles. The strong negative association between activity limitations and leisure engagement remains significant, even after we control for individual, sociodemographic characteristics and country. This study provides a window into leisure engagement in later life and factors influencing the magnitude of engagement in leisure activities.

Raising the awareness about adequate lifestyles is important to ensure adherence to activities that help prevent frailty and adverse health outcomes. This topic is studied by two articles, which look from different viewpoints at the factors influencing lifestyles in older adults. Built environment is just one of many factors affecting older adult's opportunities to age actively. Modifications to their surrounding built environments, may be insufficient to the task of overturning their unwillingness to move outdoors on foot because of fear of falls and injuries, traffic, and poorly maintained pedestrian infrastructure, increasing their personal expectations about aging and changing the perceived comfort and convenience of the motor vehicle.

In the study "Active Aging: Exploration into Self-Ratings of "Being Active," Out-of-Home Physical Activity, and Participation among Older Australian Adults Living in Four Different Settings," the authors investigated whether self-ratings of "being active" among older people, living in four different settings (major city high and lower density suburbs, a regional city, and a rural area), were associated with out-of-home participation and outdoor physical activity. Self-ratings of "being active" were found to be positively correlated with the number of days older people spent time away from home but unrelated to time traveled by active means (walking and biking). No significant differences in active travel were found between the four study locations, despite differences in their respective built environments. The findings suggest that additional strategies to the creation of "age-friendly" environments are needed if older people are to increase their levels of outdoor physical activity.

Clinical determinants of physical activity include onset of diseases such as osteoporosis and osteoarthrosis, which can determine a decline in time spent performing physical activity and functional fitness and quality of life with consequent increase in sitting time.

The aim of the review article "Functional Fitness and Self-Reported Quality of Life of Older Women Diagnosed with knee osteoarthrosis: A Cross-Sectional Case Control Study" was to evaluate the functional fitness and self-reported quality of life, differences in older people diagnosed with knee osteoarthrosis who participated in health promotion groups. Ninety older women were distributed into two groups: control without osteoarthrosis of the knee (Control, $n = 40$) and a group diagnosed with primary and secondary knee osteoarthrosis with grade II or higher, with definite osteophytes (osteoarthrosis, $n = 50$). No differences were found between ages of groups (Control: 66 ± 7; osteoarthrosis: 67 ± 9 years). Statistical differences were found on all functional fitness parameters investigated. The values of the chair stand test in the osteoarthrosis (13 ± 5; rep) group were different when compared to the Control group (22 ± 5; rep); additionally, there was a deficit in strength in the lower limbs of 40% when the two groups were compared. This data suggests that knee osteoarthrosis, in older women, can promote a decline in time spent performing physical activity and functional fitness. This is accompanied by a decline in quality of life with an increase in sitting time.

Information Communication Technology (ICT) tools provide sustainable and innovative interventions, which can be adapted to support different health needs of older adults, such as prescription adherence, which can be monitored by ICT tools (e.g., through mobile applications), physical training, and cognitive stimulation.

In the article "A Community-Based, Technology-Supported Health Service for Detecting and Preventing Frailty among Older Adults: A Participatory Design Development Process," the authors discuss the development of a community-based, technology-supported health service for detecting prefrailty and preventing frailty and further functional decline via participatory design with a wide range of stakeholders, such as physicians and local service providers. The result is an innovative service model in which an online platform supports the integration of traditional services with novel, ICT supported tools.

The aim of the article "Self-Assessment of Adherence to Medication: A Case Study in Campania Region Community-Dwelling Population" was to assess a self-reported medication adherence measure in patients selected during a health education and health promotion focused event, held in the Campania region. The study also assessed sociodemographic determinants of adherence. A total of 312 participants were interviewed during the Health Campus event. A total of 187 (59.9%) had low adherence to medications. Pearson's bivariate correlation showed positive association between the MMAS-8 score and gender, educational level, and smoking. A multivariable analysis showed that the level of education and smoking were independent predictors of adherence. Individuals with an average level of education and smoking were found to be more adherent to medication than those with a lower level of education and smoking. In conclusion, the analysis showed very low prescription adherence levels in the interviewed population. The level of education was a relevant predictor associated with that result.

Risk assessment for different factors is very relevant to identify effective preventive measures. In this issue, different examples are provided of relevant risk components for health outcomes.

In the article "Which Part of a Short, Global Risk Assessment, the Risk Instrument for Screening in the Community, Predicts Adverse Healthcare Outcomes?" the authors investigate the contribution that the three components of the RISC (concern, its severity, and the ability of the caregiver network to manage concern) make to the accuracy of the instrument, across its three domains (mental state, activities

of daily living (ADL), and medical state), by comparing their accuracy to other assessment instruments in the prospective Community Assessment of Risk and Treatment Strategies study. Risk of hospitalization was difficult to predict. Thus, each component, but particularly the caregiver network, had reasonable accuracy in predicting institutionalization. No subtest or assessment instrument accurately predicted risk of hospitalization.

The article "Sarcopenia Is Associated with High Pulse Pressure in Older Women" shows a relationship between changes in muscle mass and the cardiovascular system, although this relationship needs further studies to be fully elucidated. Sarcopenic older women ($n = 43$) presented higher levels of pulse pressure (PP) (60.3 ± 2.6 mmHg) and lower muscle function (0.5 ± 0.0 m/s) compared with nonsarcopenic subjects ($n = 87$) (53.7 ± 1.5 mmHg; 0.9 ± 0.0 m/s). Linear regression analysis demonstrated a significantly negative association between skeletal muscle index (SMI) and PP levels. Furthermore, sarcopenic older women showed a 3.1-fold increased risk of having higher PP levels compared with nonsarcopenic women (IC = 1.323–7.506). In conclusion, sarcopenic older women showed lower muscle function and higher cardiovascular risk due to increased PP levels compared with nonsarcopenic subjects.

One of the most important risks for adverse health outcomes for older adults is represented by falls.

The review article "Falls Reduction and Exercise Training in an Assisted Living Population" examines the association between the Boston FICSIT (Frailty and Injuries: Cooperative Studies of Intervention Techniques) exercise program (the original exercise program to demonstrate that nursing home residents can increase strength) and falls incidents in an assisted living community. Among 39 participants, 33% ($n = 13$) reported a fall incident. Adults without a fall history reported more time in aerobic (26.30 versus 20.00, P value = 0.71) and strength (1.50 versus 0.50, P value = 0.01) training sessions compared to those with a fall history. Multivariate models adjusting for covariates illustrated a significant protective association between strength training and fall incidents (OR = 0.25; 95% CI = 0.07, 0.85). In this cross-sectional study, this progressive resistance exercise training program in an assisted living population was associated with a decrease in the number of fall incidents.

The living environment influences the feelings of perceived well-being and is also important to facilitate stimulating activities fitted to older adults. Standardized arrangements for nursing homes bring the risk of depriving older adults of their memories and negatively influence their willingness to stay involved. Instead, residents should have the freedom to live the lives they want to lead and make changes to their room (by adding personal belongings) without hampering the provision of care. In line with such actions, it should be interesting to explore the degree of freedom a nursing home resident has in relation to making modifications to the home environment or private room.

The study "Picture Your Nursing Home: Exploring the Sense of Home of Older Residents through Photography" investigated which factors in the physical and social environment correlate with the sense of home of the residents and which environmental factors are most meaningful. The four themes identified are (1) the physical view; (2) mobility and accessibility; (3) space, place, and personal belongings; and (4) the social environment and activities. A holistic understanding of which features of the built environment are appreciated by the residents can lead to the design and retrofitting of nursing homes that are more in line with personal wishes.

An ageing society is a challenge and an opportunity to evolve our societies in inclusive and caring ecosystems, where our cultural heritage is valued through the memories of our older adults and bridged to the younger population through intergenerational activities that take advantage of the most up-to-date tools and are capable of driving novel value chains.

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Research Article

Sarcopenia Is Associated with High Pulse Pressure in Older Women

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Introduction. Sarcopenia is a geriatric syndrome associated with impairment of muscle function, metabolism, and cognition in older women. Recent studies have shown a relationship between changes in muscle mass and the cardiovascular system. However, this relationship has not been fully elucidated. *Methods*. One hundred and thirty community-dwelling Brazilian older women (65.4 ± 6.3 years) were recruited to participate in this study. Data on body composition (via bioelectrical impedance measurements), cardiovascular parameters (using an automatic and noninvasive monitor), and muscle function (using a 3-meter gait speed test) were measured. *Results*. Sarcopenic older women ($n = 43$) presented higher levels of pulse pressure (PP) (60.3 ± 2.6 mmHg) and lower muscle function (0.5 ± 0.0 m/s) compared with nonsarcopenic subjects ($n = 87$) (53.7 ± 1.5 mmHg; 0.9 ± 0.0 m/s) ($P < 0.05$). Linear regression analysis demonstrated a significantly negative association between skeletal muscle index (SMI) and PP levels ($\beta = -226$, $P < 0.05$). Furthermore, sarcopenic older women showed a 3.1-fold increased risk of having higher PP levels compared with nonsarcopenic women (IC = 1.323–7.506) ($P < 0.05$). *Conclusion*. Sarcopenic older women showed lower muscle function and higher cardiovascular risk due to increased PP levels compared with nonsarcopenic subjects.

1. Introduction

Sarcopenia is a geriatric syndrome primarily characterized by progressive and generalized loss of skeletal muscle mass. In addition, it is strongly associated with the aging process and can be exacerbated in the presence of pathological conditions (e.g., diabetes mellitus type II) [1–5]. Sarcopenia negatively affects the autonomy and quality of life of older adults in different ways (e.g., by decreasing muscle strength and muscle power and increasing the risk of falls) [6]. In this respect, sarcopenia is associated with increased risk of falls and bone fractures, cognitive and muscle impairment, frailty, impaired performance of activities of daily living, loss of independency, and early death [1–5].

With regard to metabolic processes, older adults with lower skeletal muscle index (SMI) can present hyperinsulinemia, dyslipidemia, high levels of glycosylated hemoglobin, and predisposition to prediabetic and metabolic syndrome conditions, particularly if SMI is associated with obesity [7, 8]. Moreover, sarcopenic and nonsarcopenic older adults showed higher levels of insulin resistance and fasting glucose compared with nonsarcopenic older adults [4].

Although some studies demonstrated the relationship between morphofunctional and metabolic alterations due to sarcopenia, the effects of the decrease in skeletal muscle mass on the cardiovascular system are still inconclusive. Recent studies have reported that alterations in the SMI and

increased arterial stiffness can negatively affect the cardiovascular system [9–11]. Ochi and colleagues [9] indicated that older adults with lower thigh muscle cross-sectional area presented higher levels of risk factors for cardiovascular disease, including increased intima-media thickness and increased pulse-wave velocity. Similarly, Abbatecola and colleagues [10] observed higher pulse-wave velocity in American older adults with lower SMI.

Pulse pressure (PP) is a simple and inexpensive measurement of arterial stiffness and is closely related to pulse-wave velocity [12, 13]. Furthermore, meta-analysis data indicate that increased PP is a good predictor of cardiovascular death and death from other causes in older people [14].

Therefore, in addition to the impairment of muscle function, autonomy, and metabolism caused by sarcopenia in older adults, recent studies showed a possible negative effect of sarcopenia on the cardiovascular system [4, 9]. Therefore, the aim of the present study was to evaluate the relationship between the sarcopenia index and hemodynamic dysfunctions in older women. The proposed hypothesis is that high levels of sarcopenia can negatively influence hemodynamic variables.

2. Methods

2.1. Study Design. This cross-sectional study evaluated 130 community-dwelling older women living in Brazil. All volunteers were recruited from two specialized healthcare centers for older women: (I) a community center for older adults and (II) Institute Reborn for seniors. In both centers, volunteers developed activities that involved predominantly the physical and cognitive domains. The physical activities offered were (1) a multimodal exercise program, which stimulates some physical capabilities (i.e., muscle strength, muscle power, and cardiorespiratory fitness) in the same session of exercise; these sessions lasted approximately 40 minutes and were performed in low-moderate intensity; (2) water aerobics; (3) folk dance; and (4) yoga. Painting was the only activity that involved predominantly the cognitive domain. After registration, older adults were automatically enrolled in all activities. However, they were not required to participate in or perform activities every day.

Participation in the present study involved the completion of all measurements after signing the informed consent form. This study was approved by the Research Ethics Committee of the Universidade de Mogi das Cruzes (UMC) under protocol number 621-614. This study was developed in accordance with the Declaration of Helsinki and according to Resolution 196/96 of the National Health Council.

2.2. Participants. All older women were ≥60 years of age. The exclusion criteria were use of hormone replacement and/or psychotropic drugs, cardiovascular disease (e.g., acute myocardial infarction, stroke, peripheral arterial disease, and transient ischemic disease), pulmonary disease, neurological or psychiatric disease (e.g., Parkinson's or Alzheimer's disease), musculoskeletal disorders, and comorbidities associated with greater risk of falls. All clinical information (i.e., disease status, age, and drug therapy) was obtained by reviewing the medical records of each subject.

All subjects were instructed to refrain from physical exercise for 96 hours before the tests and to refrain from eating or drinking (including water) for 8 hours before the tests. All tests were conducted between 07:00 am and 10:00 am under a controlled temperature of 26°C.

2.3. Measurements

2.3.1. Assessment of Body Composition and Sarcopenia. A data acquisition system (Tanita InnerScan 50v, Tokyo, Japan) was used to measure the bioelectrical impedance. This system uses an electrical current to quantify the amount of intracellular and extracellular water in the body. The device has four electrodes: two are placed on the feet while the other two are placed on the hands of the volunteers. The device measures body mass index (BMI), total body mass, total muscle mass, and percentage of fat mass [15]. Sarcopenia was defined by the criterion of Janssen and colleagues [16]. In summary, the bioelectrical impedance test allows the normalization of absolute muscle mass (AMM) to height (AMM/height^2), which is denominated skeletal muscle mass index (SMI). Sarcopenia was classified into tertiles [11]. Older women classified into the first tertile (<15, 68 kg/m^2) were classified as sarcopenic.

2.3.2. Cardiovascular Parameters. All cardiovascular parameters were analyzed at rest. The procedures for the measurement of blood pressure were adapted from the VII Joint National Committee of High Blood Pressure (JNC7) [17]. In summary, older women remained in the sitting position in a comfortable chair for 15 minutes in a dark and quiet room. After this period, a cuff with the right size was placed approximately at the midpoint of the upper left arm (heart level). An automatic, noninvasive and validated [18] arterial blood pressure monitor (Microlife-BP 3BT0A, Microlife, Widnau, Switzerland) was used to measure systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR). The mean arterial pressure (MAP), rate pressure product (RPP), and pulse pressure (PP) were evaluated according to the following equations: $MAP = [SBP + (2 * DBP)]/3$; $RPP = SBP * HR$; $PP = SBP - DBP$ [12, 19]. The size of the arm cuff was selected after measuring the arm circumference (Sanny, São Paulo, Brazil).

2.3.3. Muscle. Muscle function was evaluated using the 3-meter walk speed test (WS) test. During the test, the volunteers were instructed to walk a distance of 5 meters at a normal cadence. To ensure this, the researcher requested the following: "Please, walk as you were going to a supermarket or bakehouse." Volunteers should remain with both feet on the starting line and counting started when one foot touched the 1-meter line and stopped when one foot touched the 4-meter line. After a 1-minute rest, a second attempt was made. The mean values were used in the analysis [15].

2.3.4. Pathological Conditions and Cofactors. Medical records were reviewed to obtain information of the health status of

Table 1: Comparison between the groups with regard to morphological and functional variables and health indicators.

	Healthy patients (n = 87)	Sarcopenic patients (n = 43)	P
Age (years)	64.1 ± 0.8	64.5 ± 0.5	ns
Body mass (kg)	66.2 ± 1.0	66.3 ± 2.5	ns
Height (cm)	155.9 ± 0.0	156.8 ± 0.0	ns
Body mass index (kg/m^2)	28.1 ± 0.4	24.3 ± 0.5	<0.05
Absolute muscle mass (kg)	41.5 ± 0.4	34.9 ± 1.3	<0.05
Skeletal muscle index (kg/m^2)	17.4 ± 0.1	14.6 ± 0.1	<0.05
Fat mass (%)	34.8 ± 0.8	36.4 ± 1.7	ns
SBP (mmHg)	138.8 ± 0.0	144 ± 0.1	ns
DBP (mmHg)	84.3 ± 1.1	83.4 ± 2.1	ns
MAP (mmHg)	102.6 ± 1.3	103.7 ± 2.1	ns
HR (bpm)	75.7 ± 1.2	74.9 ± 1.7	ns
RPP (mmHg·bpm)	10530 ± 256.7	10750 ± 303.9	ns
PP (mmHg)	53.7 ± 1.5	60.3 ± 2.6	<0.05
Functionality (m/s)	0.9 ± 0.0	0.5 ± 0.0	<0.05
Hypertension (%)	41.0	65.0	ns
Diabetes mellitus type II (%)	4.4	5.8	ns
Metabolic syndrome (%)	4.0	4.0	ns
Respiratory pathology (%)	4.0	1.0	ns
Mean of drugs	1.1 ± 0.1	1.7 ± 0.2	ns
Smoker (%)	5.0	5.0	ns

Data are presented as mean ± SE. SBP = systolic blood pressure; DBP = diastolic blood pressure; MAP = mean arterial pressure; HR = heart rate; RPP = rate pressure product; PP = pulse pressure.

each volunteer. The head physician recorded the pathological conditions but a specialist not affiliated to/outside the center made the pathologic diagnosis. The cofactors (the number of drugs used by older women (mean of drugs) and smoking status) were recorded by a head nurse after interviewing the participants. The medical records were updated every six months.

2.4. Statistical Analysis. The Shapiro-Wilk test was used to calculate data normality. Student's t-test was used to compare quantitative variables and χ^2 was used to compare qualitative variables. Pearson's correlations were conducted with and without adjusting for pathological conditions. After statistical analyses, it was verified that PP values were higher in the sarcopenic group and were significantly associated with SMI; subsequently, the correlation between SMI and PP was investigated. Stepwise linear regression was conducted to predict the best model to evaluate the association between SMI and PP. Multiple linear regression analysis was used to assess the significance of the proposed model. To assess whether the IMM was a risk factor for PP, logistic regression was conducted. Differences were considered statistically significant at $P < 0.05$. Sample size was determined on the basis of a population of 112.481 individuals and a confidence level of 95%. All analyses were conducted using the Statistical Package for the Social Sciences (SPSS; IBM, Chicago, IL, USA) software version 20.0.

3. Results

Subjects were dichotomized in two groups according to the SMI cutoff. Table 1 presents the characteristics of the study group. Sarcopenic older women presented lower values of BMI, SMI, and AMM and lower muscle function but higher PP values compared with normal older women.

Pearson's correlation was performed to assess possible associations between the cardiovascular variables and SMI. Our results showed a significantly negative association between SMI and PP (−0.25; $P = 0.03$). Moreover, adjustment for pathological conditions alone or in combination did not change the significance of the association (hypertension (−0.25; $P = 0.05$); diabetes mellitus type II (−0.25; $P = 0.05$); metabolic syndrome (−0.25; $P = 0.04$); respiratory pathology (−0.25; $P = 0.05$); and metabolic syndrome together with respiratory pathology (−0.25; $P = 0.04$)).

Table 2 shows data on linear and multiple linear regression. The findings on linear regression showed a significant R^2 (0.49) for IMM in relation to PP. However, multiple regression did not show significant results for any of the proposed models from stepwise linear regression.

The odds ratio results indicate that older women with sarcopenia have three times increased risk (3.151) of having increased PP values compared with nonsarcopenic volunteers (1.323–7.506 (95% confidence interval), $P < 0.05$).

4. Discussion

The results of the present study indicate that sarcopenic older women have lower muscle function and higher PP levels compared with nonsarcopenic older women. These results were confirmed by using multilinear and linear regression and indicate a significantly negative association between SMI and PP. Furthermore, sarcopenic volunteers had a three times

Table 2: Linear and multilinear regression considering pulse pressure as the dependent variable.

Variable(s)	R^2	β	P
SMI	0.49	−0.226	<0.05
Model 1	0.94	0.157	ns
Model 2	0.136	0.104	ns
Model 3	0.174	0.98	ns

SMI = skeletal muscle index; Model 1 = SMI plus age; Model 2 = Model 1 plus metabolic syndrome, smoking status, hypertension, and diabetes mellitus type II; Model 3 = Model 2 plus height and functionality.

higher risk of having increased PP values compared with nonsarcopenic individuals.

These findings are in accordance with those of other studies, which demonstrated a relationship between the sarcopenia index and cardiovascular alterations in older adults [4, 9–11, 20]. Recently, Han and colleagues [4] evaluated a large sample of older Koreans ($n = 4.846$) and observed a higher prevalence of hypertension in sarcopenic older adults compared with nonsarcopenic adults, regardless of the obesity level. In addition, nonobese sarcopenic older adults had a 1.5 times higher risk of presenting with hypertension compared with nonsarcopenic subjects.

Furthermore, other experiments have investigated whether sarcopenia could be associated with increased arterial stiffness, which can promote the development of hypertension as well as other cardiovascular and cerebrovascular diseases [12, 21–23]. It has also been demonstrated that increased PP levels are an important risk factor for coronary heart disease [18].

Similar to the results of the present study, other studies demonstrated an association between the degree of sarcopenia and arterial stiffness. These experiments observed that increase in sarcopenia was associated with increase in brachial-ankle pulse-wave velocity in Japanese [7, 11, 20] and American older adults [10]. Furthermore, Srikanthan and Karlamangla [7] observed that the sarcopenia index was negatively associated with carotid intima-media thickness, suggesting a possible correlation with the formation of atherosclerotic plaques.

In the present study, older women with lower SMI showed higher odds ratio for higher PP levels compared with nonsarcopenic women. Higher levels of brachial PP are associated with increased pulse-wave velocity, which is mainly due to the decrease large-vessel compliance [12]. Complications associated with higher PP values have been previously studied [21–23]. In normotensive and hypertensive populations, higher PP was the most important determinant of the risk of death (mainly due to cardiovascular complications) [21, 22]. For this reason, the possibility of using PP as a better predictor of cardiovascular death compared with other hemodynamic measurements (e.g., SBP and DBP) has been recently considered [23].

One of the limitations of the present study was the failure to assess the influence of pathological conditions on the association between SMI and PP. However, no changes were observed in our results using Pearson's correlation and multilinear regression after adjusting for morbidities. Diabetes type II (DMTII) seems to enhance the loss of muscle mass primarily in individuals with uncontrolled glycemia [5–24]. Furthermore, patients with low SMI with and without DMTII demonstrated increased insulin resistance, hyperinsulinemia, and glycosylated hemoglobin levels compared with individuals with higher SMI [7]. Recent evidence suggests a potential correlation between sarcopenia and dyslipidemia, which leads to hyperglycemia and ultimately metabolic syndrome [8]. However, these data were not confirmed in the present study.

It is possible that the number of volunteers with pathologies was insufficient to evaluate the impact of each condition on the parameters evaluated. However, an advantage of the limited number of older people with illnesses is that, even in healthy older women, decreased muscle mass can impair the cardiovascular system.

A possible mechanism that could explain the association between SMI and higher PP levels in the sarcopenic group is increased chronic inflammation due to decreased muscle function, which can lead to physical inactivity. Decreased muscle function resulted in higher levels of inflammatory markers in the blood of older adults [25]. Chronic low-grade inflammation is characterized by an increase in blood levels and gene expression of proinflammatory cytokines, which can—via paracrine and autocrine mechanisms—decrease the bioavailability of nitric oxide, increase arterial stiffness, increase the formation of atherosclerotic plaques, and promote endothelial dysfunction, which, in turn, can promote an increase in PP levels [26–28].

On the other hand, the increase in muscle activity has been suggested as a mechanism that can inhibit chronic low-grade inflammation [29]. It is known that bioactive proteins known as myokines (e.g., IL-6) are produced by muscle fibers from muscle contraction [30, 31]. Myokines can inhibit the activity of proinflammatory cytokines (e.g., TNF-α), thereby avoiding the deleterious effect of cytokines on the human body [25, 27]. Animal experiments showed that the increase in muscle activity by physical exercise could decrease the activity of TNF-α in mice that overexpress this protein [32]. In addition, the cytokine levels of volunteers who practiced physical exercise in the same day and who were stimulated to produce TNF-α did not increase. However, the group that did not practice physical exercise had increased TNF-α concentrations [33]. In the present study, nonsarcopenic older women with improved muscle function possibly performed more muscle contractions, which led to the increased production of myokines, which in turn acted as a protective factor against chronic low-grade inflammation.

Insulin resistance can also explain the results of this study. Individuals with low SMI with and without diabetes demonstrated increased insulin resistance, hyperinsulinemia, and increased levels of glycosylated hemoglobin compared with individuals with higher SMI, which was probably caused by decreased insulin levels in the target organ [7]. Furthermore, hyperinsulinemia due to insulin resistance can activate NFκB, which is an important regulator of the production of proinflammatory cytokines [34]. Clearly, a synergistic effect

of both mechanisms cannot be discarded and is probably the best explanation.

Interestingly, the cofactors identified in the present study (BMI, percentage of body fat, age, and muscle function) had no effect on the association between SMI and PP. Other factors that can influence vascular homeostasis, such as nitric oxide, cholesterol, and low- and high-density lipoproteins, can be used to create a better model to investigate the relationship between SMI and PP. Moreover, studies involving study groups with specific pathologic conditions, such as DMT2, hypertension, obesity, and metabolic syndrome, can help elucidate the impact of pathological conditions on muscle mass homeostasis and their effect on the cardiovascular system [5, 8].

Some of the limitations of the present study include (i) its cross-sectional design, which precluded the assessment of a time-effect relationship; (ii) the limited number of volunteers enrolled, which can be partially explained by sample homogeneity, which contributed to a better understanding of the effect of sarcopenia on older women; and (iii) the absence of biochemical measurements, which could have elucidated possible interacting mechanisms. However, to the best of our knowledge, this is the first study that addressed the relationship between low SMI and changes in the arterial stiffness index in Brazilian older women.

5. Conclusion

The present study showed that older women with higher SMI (which is predominantly influenced by an active lifestyle) presented lower PP levels and decreased cardiovascular risk whereas older women with a sarcopenic profile had a cardiovascular risk 3 times higher than that of nonsarcopenic women. Therefore, beneficial therapies, such as strength exercise, can help increase or maintain muscle mass and consequently improve the quality of life of older people.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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Research Article

Self-Assessment of Adherence to Medication: A Case Study in Campania Region Community-Dwelling Population

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Objectives. The aim of the study was to assess self-reported medication adherence measure in patients selected during a health education and health promotion focused event held in the Campania region. The study also assessed sociodemographic determinants of adherence. *Methods*. An interviewer assisted survey was conducted to assess adherence using the Italian version of the 8-item Morisky Medication Adherence Scale (MMAS-8). Participants older than 18 years were interviewed by pharmacists while waiting for free-medical checkup. *Results*. A total of 312 participants were interviewed during the Health Campus event. A total of 187 (59.9%) had low adherence to medications. Pearson's bivariate correlation showed positive association between the MMAS-8 score and gender, educational level and smoking ($P < 0.05$). A multivariable analysis showed that the level of education and smoking were independent predictors of adherence. Individuals with an average level of education (odds ratio (OR), 2.21, 95% confidence interval (CI), 1.08–4.52) and nonsmoker (odds ratio (OR) 1.87, 95% confidence interval (CI), 1.04–3.35) were found to be more adherent to medication than those with a lower level of education and smoking. *Conclusion*. The analysis showed very low prescription adherence levels in the interviewed population. The level of education was a relevant predictor associated with that result.

1. Introduction

Medication adherence is a growing concern to healthcare systems as nonadherence to pharmacotherapy has been associated with adverse outcomes and higher costs of care.

Medication nonadherence is likely to grow as the population ages and as patients need to take more medications to treat chronic conditions. Several studies highlighted that the levels of adherence to treatment in patients with chronic diseases are inadequate showing rates that do not exceed 50%. Adherence and persistence to drug treatment represent the key factors necessary to gain a significant reduction in morbidity and mortality and to optimize the use of financial resources, but these aspects are widely underestimated in clinical practice and by patients [1–5]. The World Health Organization (WHO) estimates that the cost of nonadherence to drug therapy amounts to 125 million euros per year in Europe [6].

The approaches used to assess medication adherence include direct or indirect methods. Indirect methods include patient interviews, pill counts, refill records, and measurement of health outcomes. However, the most practical approach to apply in clinical practice is patient self-report. The advantages of assessing medication adherence by self-report included simplicity, speed, and viability of use [7]. The Morisky Medication Adherence Scale (MMAS-8) is one of the most commonly used self-reporting methods [8, 9].

In addition, the MMAS-8 provides information on behaviors associated with low adherence that may be unintentional (e.g., forgetfulness) or intentional (e.g., stopped taking

medication(s) without telling the doctor, because they felt worse when they took it). Identification of these behaviors can facilitate tailoring of interventions to specific patient issues and is strongly related to concordance [7, 10].

Currently there are many studies evaluating the degree of adherence to treatment in patients with specific diseases [7, 11–13], while there seems to be a lack in the literature related to adherence to treatment in the general population.

The purpose of the current analysis was to evaluate adherence to medication in the general population during a prevention-related event held in Campania region (Southern Italy). The interview was carried out by administering the Italian version MMAS-8 questionnaire.

2. Materials and Methods

2.1. Setting. The prevention-related event was organized by the Health Campus, a nonprofit organization. It was established to carry out a continuous activity of dissemination and promotion of prevention through specific clinical screening and educational initiatives. The study is part of a larger activity that started in 2010 to assess the health status of the general population of the Campania Region, by providing free consultation, visits, and diagnostics for people coming to the outdoor hospital held in different public squares of Campania region during popular events [14].

The Health Campus focuses its energy and resources primarily on two major objectives: first, to provide specialist visits for disease prevention and early detection of risks to the health of Campania citizens; second, to promote dissemination of a culture of prevention that encourages a change in lifestyle for healthy living.

The Health Campus events periodically set up a disease prevention "Field Clinic," where early diagnosis tests are offered to the general public free of charge. Thus the public is encouraged to undergo specialist examinations and is informed about health risks and good practice habits to adopt for early diagnosis and screening.

The Health Campus is typically set up during large, popular events or at the request of public and/or private organizations.

2.2. Study Design. A cross sectional assisted interview survey was conducted by pharmacists on a population group selected during the Health Campus event held in Naples in April 2013 during the America's Cup.

People who were attending the event and were interested to undergo clinical evaluation and/or to take the opportunity of the available screening services, upon arrival, were selected as eligible if they were 18 years or older and taking at least one medication for at least one chronic condition. While waiting to receive a medical checkup, they were invited to the assessment of medication adherence and were interviewed by pharmacists. All participants provided their written informed consent to the study that was conducted in line with the Helsinki declaration for human studies.

The information collected included demographic data (i.e., age and gender), level of education (referred to Italian education system), smoking habit, number of drugs taken, and type of chronic disease present such as hypertension, diabetes, heart failure, COPD, renal failure, and osteoporosis. Self-reported adherence was assessed using the Italian validated version of the Morisky Medication Adherence Scale (MMAS-8) [15]. Use of the MMAS is protected by US copyright laws. Permission for use is required. This scale has been validated and used in many languages [12, 15, 16]. It consists of eight items that address specific behavior regarding medication assumption and both intentional and unintentional adherence (questionnaire used for interview is reported as Supplementary Material available online at http://dx.doi.org/10.1155/2015/682503, Table S1).

Scores on the Morisky Medication Adherence Scale can range from 0 to 8, scores < 6 reflecting low adherence, scores $\geq 6 < 8$ reflecting medium adherence, and scores $= 8$ reflecting high adherence [17].

In this study, none of the interviewed participants reported high adherence on the Morisky scale, so the dependent variable of patient adherence was dichotomized into 2 groups: low adherence (scores < 6) versus medium adherence (scores ≥ 6) [18].

The MMAS provides information on behaviors associated with low adherence that may be unintentional (e.g., forgetfulness) or intentional (e.g., stopped taking medication(s) without telling the doctor, because they felt worse when they took it) [7]. The MMAS-8 is divided into 4 items that assess intentional nonadherence and 4 items that assess unintentional nonadherence. We divided participants with low adherence into two categories: intentional nonadherent when majority of answers provided indicate a behavior that is not related to forgetfulness and unintentional nonadherent when majority of answers provided indicate a behavior that is related to forgetfulness.

2.3. Statistical Analyses. Baseline characteristics of the study population were analyzed using descriptive statistics and their degree of adherence, chi square test, and Student's t-test were used where appropriate. Pearson's correlation was used to assess bivariate association between adherence score and participant characteristic.

Additionally, associations between adherence and covariates were evaluated after accounting for other variables and predictors using logistic regression. The initial model included gender, smoking, and educational level. Factors were then sequentially eliminated from the multivariate model until only factors significant at the level of $P < 0.05$ remained in the final model. All analyses were performed using SPSS software version 17.1 for Windows (SPSS Inc., Chicago, IL, USA).

3. Results

312 patients were interviewed during the Health Campus event. The mean age was 61.8 (SD ±11.1) years. 57.4% of participants were women.

The characteristics of the analyzed population and the results of univariate association between low adherence on the Morisky scale and patient-reported factors are reported in Table 1.

Table 1: Univariate association between low adherence on the Morisky scale and patient-reported factors.

	Low adherence N = 187 (59.9%)	Medium adherence N = 125 (40.1%)	Total N = 312 (100.0%)	P value
Age group				0.58
Mean (±SD)	62.0 (11.4)	61.7 (10.8)	61.8 (11.1)	
18–60	75 (58.1)	54 (41.9)	129 (100.0)	
≥60	112 (61.2)	71 (38.8)	183 (100.0)	
Gender				0.03
Male	89 (66.9)	44 (33.1)	133 (100.0)	
Female	98 (54.7)	81 (45.3)	179 (100.0)	
Educational level				0.01
Primary school graduation	34 (68.0)	16 (32.0)	50 (100.0)	
Secondary school graduation	65 (69.9)	28 (30.1)	93 (100.0)	
High school graduation	55 (50.0)	55 (50.0)	110 (100.0)	
Degree graduation	33 (55.9)	26 (44.1)	59 (100.0)	
Number of medications				0.62
Mean (±SD)	2.33 (1.6)	2.15 (1.5)	2.26 (1.58)	
1	77 (56.6)	59 (43.4)	136 (100.0)	
2-3	71 (60.7)	46 (39.3)	117 (100.0)	
4-5	21 (67.7)	10 (32.3)	31 (100.0)	
≥6	18 (64.3)	10 (35.7)	28 (100.0)	
Smoking				0.03
No	136 (56.7)	104 (43.3)	240 (100.0)	
Yes	51 (70.8)	21 (29.2)	72 (100.0)	
Number of diseases				0.08
Mean (±SD)	1.58 (0.87)	1.46 (0.64)	1.53 (0.78)	
1	111 (59.4)	76 (40.6)	187 (100.0)	
2	52 (55.9)	41 (44.1)	93 (100.0)	
≥3	24 (75)	8 (25)	32 (100.0)	
Heart failure				0.58
No	171 (60.4)	112 (39.6)	283 (100.0)	
Yes	16 (55.2)	13 (44.8)	29 (100.0)	
COPD				0.35
No	183 (59.6)	124 (40.4)	307 (100.0)	
Yes	4 (80.0)	1 (20.0)	5 (100.0)	
Gastritis				0.42
No	172 (59.3)	118 (40.7)	290 (100.0)	
Yes	15 (68.2)	7 (31.8)	22 (100.0)	
Renal failure				0.68
No	185 (60.1)	123 (39.9)	308 (100.0)	
Yes	2 (50.0)	2 (50.0)	4 (100.0)	
Osteoporosis				0.15
No	168 (58.7)	118 (41.3)	286 (100.0)	
Yes	19 (73.1)	7 (26.9)	26 (100.0)	
Diabetes mellitus				0.51
No	163 (59.3)	112 (40.7)	275 (100.0)	
Yes	24 (64.9)	13 (35.1)	37 (100.0)	
Hypertension				0.76
No	87 (60.8)	56 (39.2)	143 (100.0)	
Yes	100 (59.2)	69 (40.8)	169 (100.0)	

18.9% of patients have a degree graduation, 35.3% of patients had high school graduation whereas 29.8% of patients attended secondary school graduation, and 16.0% finished the primary schools.

A total of 40.1% of patients had 2 or more diseases. More specifically, patients with hypertension were 169 (54.2%); 37 (11.9%) had type II diabetes; 29 (9.3%) had heart failure; 26 (8.3%) had osteoporosis; 22 (7.1%) had gastritis; 5 (1.6%) had COPD; and 4 (1.3%) had renal failure. A total of 37.5% of patients took from 2 to 3 drugs and 59.9% of patients have at least one disease. A total of 76.9% of patients were nonsmoking.

In the overall population, 59.9% of participants demonstrated low adherence and 40.1% medium adherence. Nobody showed high adherence. The mean score for the medication adherence scale was 4.95 (±1.52). Table 1 shows the characteristics of the population and the significant results ($P < 0.05$) of the univariate analyses examining the associations between scores on the Morisky scale and patient-reported factors.

Considering the frequency distribution of the MMAS-8 items, 42.6% of patients answered that they forgot to take their medicines, 47.1% of patients had problems taking their medicines in the last two weeks, 21.8% of patients have stopped taking their medicines without telling their doctor, 55.4% of patients stated that when they travel they forgot to bring along their medication, 20.2% of patients stated that when they feel like their condition is under control, they stop taking their medication, and 18.3% of patients felt hassled about sticking to their treatment plan. In conclusion, 19.9% of patients have difficulty remembering to take all their medications.

A total of 60.9% of nonadherent participants were intentional, 13.4% of nonadherent subjects were unintentional, and 25.7% of nonadherent participants did not fall within either category.

The number of medications prescribed, age, and number of diseases are not significant.

However, educational level, smoking habit, and gender were statistically significant (P = 0.01; 0.03; 0.03, resp.) (Table 1).

Univariate analysis showed that males have a higher risk of being low adherent than women (odds ratio (OR) 1.67, 95% confidence interval (CI), 1.05–2.66); the risk of being nonadherent to treatment for smokers is about double compared to nonsmokers (odds ratio (OR) 0.54, 95% confidence interval (CI) 0.30–0.95).

Only 2 factors remained as significant independent predictors of high adherence after logistic regression adjustment: level of education (P = 0.03) and smoking habit (P = 0.03) (Table 2).

People with high school graduation (odds ratio (OR), 2.21, 95% confidence interval (CI), 1.08–4.52) and nonsmokers (odds ratio (OR) 1.87, 95% confidence interval (CI), 1.04–3.35) are more adherent to treatment than those with lower education and smokers (Table 2).

Table 2: Association between adherence score with educational level and other significant variables in the regression analysis.

Variables	Odds ratio	IC 95%	P value
Gender			
Female	Reference		
Male	0.65	0.39–1.06	0.08
Smoker	Reference		
Nonsmoker	1.87	1.04–3.35	0.03
Educational level			
Primary school graduation	Reference		
Secondary school graduation	1.01	0.47–2.17	0.98
High school graduation	2.21	1.08–4.52	0.03
Degree graduation	1.63	0.74–3.62	0.23

4. Discussion

To the best of our knowledge, this is the first survey about adherence to medication that was carried out during a prevention event, among a population selected at the community level.

Previous studies on adherence have mostly been restricted to specific clinical populations, a specific disease, and/or a single treatment and the relevance of the outcomes to prescription drug users in general has been unclear [19]. Patient compliance to drug therapy is one of the most relevant issues in clinical practice as the success of a therapeutic intervention depends on the actual patient adherence to therapy. The noncompliance to treatment has direct consequences such as the distortion of the effectiveness of the treatment [20]. Furthermore, several observational studies raised many concerns about undertreatment in current clinical practice, because it leads to an increase in the number of hospitalizations and consequently an increase of the cost for the health system [21].

In industrialized countries, adherence to treatment by patients with chronic diseases is about 50% [22]. Our results are in line, showing 59.9% of low adherence to medications.

The main causes of poor adherence are the lack of motivation of the patients as well as low average education level, limited awareness about health, and the lack of perception of risk arising from treatment discontinuation [11]. This is in line with our results that showed that low level of education is a predictor of low adherence.

Moreover different studies indicate that 30% of the interviewed participants claim forgetfulness as the reason for their nonadherence, thus making it a prominent reason for nonadherence [23].

Using the MMAS-8, we were able to identify intentional and unintentional behaviors that cause low adherence [7]. About 42.6% of respondents say they do not take their medication regularly due to forgetfulness and 21.8% stop their treatment without speaking to their doctor. Intentional nonadherence indicates a lack of understanding and misconceptions regarding the chronicity of a health condition. This behavior can be related to lack of concordance, intended as the fact that the "prescriber and patient should come

to an agreement about the regimen that the patient will take" [10]. Taking medications continuously and according to the instructions of the physician is an important aspect of drug treatment. This aspect, however, does not seem to be considered by the patients: our analysis showed that no more than 40.1% of patients have a medium level of adherence.

The interview was carried out by pharmacists. Several studies showed that interventions by pharmacists, often as a part of the care team, jointly with clinicians, have been found to be effective in improving medication adherence [24, 25]. However in Italy pharmacists are not sufficiently involved in adherence-related activities, despite the fact that pharmacists are the last point of contact with the patient before beginning the use of the medications [26]. Strategies should be formulated to achieve greater involvement of pharmacists in promoting adherence [27]. For this reason we chose to involve the pharmacist in the administration of the questionnaire as a way to improve awareness about adherence-related issues among pharmacists as well.

The European Innovation Partnership A1 Action Group on Active and Healthy Ageing, in 2012, has implemented joint initiatives between various European countries to improve the quality of the prescription and adherence to treatment [28]. Many intervention strategies that are currently being discussed among partners are aimed to promote coordinated and multidisciplinary intervention by involving all major stakeholders (general practitioners and specialists, pharmacists, nurses, family, health authorities, and pharmaceutical industry). The present initiative is part of the strategy carried out by the EIP-AHA A1 Action Group and provides preliminary data that might be useful for the further focused interventions.

4.1. Limitations of the Study. This study has some obvious limitations. Participation in this study was voluntary and, as a result, there may have been a selection bias. Population has not been selected on the basis of specific diseases or according to the number of medications prescribed. Nevertheless we assume that to be a minor limitation as the study was not aimed to assess adherence in specific conditions. Our results give a first overview about level of adherence and predictive factors. A larger population could provide more robust results. The assessment of adherence in our study was based on self-reporting. Questionnaires are a self-reporting tool that is relatively simple and economical to use, but it could overestimate the rate of medication adherence [29, 30].

5. Conclusion

In conclusion, we provided information about adherence levels in a population selected among participants to a prevention-related event. The analysis showed that adherence levels were mostly low. We found that a factor that could be associated with low levels of adherence was level of education which in turn is related to inadequate health literacy. Initiatives to raise awareness of the issue are needed as well as dissemination of the fundamental principles underlying control strategies of nonadherence to therapy. Performing such initiatives requires a *collective*, joint effort that involves different categories of stakeholders, from patient to health care providers and policy makers, whose role may be different depending upon the kind of initiative and health system organization.

Conflict of Interests

None of the authors had any potential conflict of interests including any financial, personal, or other relationships with other people or organizations since three years of the beginning of the submitted work that could inappropriately influence, or be perceived to influence, their work.

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Research Article

Active Aging: Exploration into Self-Ratings of "Being Active," Out-of-Home Physical Activity, and Participation among Older Australian Adults Living in Four Different Settings

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We examined whether self-ratings of "being active" among older people living in four different settings (major city high and lower density suburbs, a regional city, and a rural area) were associated with out-of-home participation and outdoor physical activity. A mixed-methods approach (survey, travel diary, and GPS tracking over a one-week period) was used to gather data from 48 individuals aged over 55 years. Self-ratings of "being active" were found to be positively correlated with the number of days older people spent time away from home but unrelated to time traveled by active means (walking and biking). No significant differences in active travel were found between the four study locations, despite differences in their respective built environments. The findings suggest that additional strategies to the creation of "age-friendly" environments are needed if older people are to increase their levels of outdoor physical activity. "Active aging" promotion campaigns may need to explicitly identify the benefits of walking outdoors to ambulatory older people as a means of maintaining their overall health, functional ability, and participation within society in the long-term and also encourage the development of community-based programs in order to facilitate regular walking for this group.

1. Introduction

Together, the World Health Organization's [1] policy framework for active aging and its guide for the development of "age-friendly" cities [2] have set a policy and research agenda in which the built environment is conceived to play a crucial role as a facilitator or inhibitor of older people's capacity to age "actively." This theoretical standpoint assumes that built environments which are conducive to the outdoor mobility of older people will help provide them with ongoing opportunities for both participation within society and maintenance of their health through the gaining of physical exercise as they move around their neighborhoods. It remains unclear, however, whether or not older people's self-assessments of "being active" are linked to either their levels of participation within society or their engagement in outdoor physical activity, and, to date, there is no convincing evidence of a direct relationship between the built environment and older people's walking behavior.

"Active aging" is defined by the WHO [1, page 12] as "the process of optimizing opportunities for health, participation, and security in order to enhance quality of life as people age." This concept presents both opportunities and challenges to policy makers and researchers alike. In terms of policy, active aging has been acknowledged as providing a sound basis for responding to the challenges posed by population aging in industrialized nations by linking a number of key policy domains including employment, pensions, retirement, health, and citizenship [3, page 121]. Yet within Europe, for example, the focus on active aging has so far been largely limited to a "crude reduction in terms of working longer" [4, page S117]. Walker [3, page 124] noted more than a decade ago that active aging "does not amount to a coherent strategy and is sometimes just a slogan used to cover anything that seems to fit under it." More recently, he has stressed that this concept is more of an aspiration for both individuals and collectivities than it is a process that exists in practice [4, page S126]. The usefulness of the active aging concept for policy makers aiming to comprehensively address issues associated with the growing aging population will necessarily rest on their capacity to devise a coherent set of strategies that effectively deal with all of the three key determinants of

active aging identified by the WHO—participation, health, and security. The sheer scope of this concept makes this a difficult task.

One key opportunity presented to researchers by the development of the active aging concept is its potential to act as a driver for greater attention on the older person-macroenvironment relationship. Indeed, there has been unprecedented research interest in this area since the release of the WHO's [1] policy framework; prior to the early 2000s, it was the microenvironments of older people which predominated as the main focus of investigations into the older person-environment relationship (see [5]). Nevertheless, the complex, multifaceted nature of the active aging concept is problematic, especially since it effectively encompasses dimensions covered by a number of earlier concepts. These include "successful ageing" which Walker [3] traces back to the early 1960s (a concept emphasizing the importance of maintaining activity patterns and values of middle age into old age) and "productive aging" which emerged in the 1980s (mostly focused on removing barriers to older persons engaging in work—paid or unpaid—and thereby extending their productive capacity beyond retirement age). Walker [3, page 123-124] notes that "active aging" emerged in the 1990s, giving recognition to both the connection between activity and health and the importance of "healthy aging." His account of the development of the active aging concept clearly demonstrates that active aging is much broader in scope than all of these earlier concepts. Nevertheless, a review of empirical literature recently undertaken by Hung and colleagues [6] grouped "active aging" with "successful," "productive," "positive," and "robust" aging as cognates of "healthy aging"—despite the fact that the active aging concept encompasses more dimensions than any of these other concepts (including continued participation in society; the maximization of social, mental, and physical health; the maintenance of dignity, self-efficacy, and human rights; and the creation of age-friendly physical environments to facilitate autonomy and independence) (see [3, 7]). Coherency of the accumulating evidence on active aging may well be undermined by both the overlap between this concept and its predecessors and the treatment of them as interchangeable terms. It is also noteworthy that "successful aging" has now been a focus of research for around half a century and there is still no widely agreed definition for this term or consistency between studies in the measures used to investigate this subject area, and the first rigorous analysis of measures was only undertaken recently (see [8]). There would seem to be much greater potential for disagreement about how "active aging" is operationally defined by researchers given the broad scope of this concept. This is not only an issue for the research community. If active aging objectives are to be met, it would seem crucial that laypersons ascribe meanings to this term that are in line with the WHO's [1] policy framework and fully grasp the nature and importance of all of the constituents of active aging as laid out in this framework.

To date, only a few studies have explored older people's perceptions of active aging. Research undertaken in the United Kingdom by Bowling [7] found this term was most commonly conceived by a sample of older people aged 60 years and over, to involve having/maintaining physical health and functioning (43%), leisure and social activities (34%), mental functioning and activity (18%), and social relationships and contacts (15%). Comparison with academic conceptualizations of active aging showed that there was overlap between lay perceptions of the constituents of active ageing and those used in theoretical models within the literature, although the latter entailed additional components (productivity, empowerment, human rights, and dignity) to those identified by laypersons. Multiple regression analyses revealed that health status, longstanding illness, and quality of life (all based on self-report) explained 41% of the variance in self-ratings of active aging, while sociodemographic and economic variables were not significantly associated with this outcome [7, page 298]. Comparison of data gathered on the perceived constituents of active aging in this particular study with data obtained from an earlier survey of older people's perceptions of successful aging, also administered in the United Kingdom but with adults aged 50 years and over (for further details see [9]), showed that there was considerable overlap in the meanings ascribed to "active" and "successful" aging. A later study by Bowling [10] compared the perceptions of minority ethnic groups with those of the general population in the United Kingdom, revealing that ethnically diverse respondents were less likely to define active aging in terms of good physical health and fitness (and exercise to promote these two aims) and also less likely to rate themselves as aging actively than respondents within the general population. From Bowling's [7] research, it would seem that individual factors such as health status and longstanding illness impact on older people's self-assessments of aging actively, but we currently have little understanding of whether or not there is any relationship between these self-assessments and the actual behaviors of older persons with respect to their actual levels of participation and physical activity outside of the home domain.

Older people's participation in the wider community necessarily relies on their capacity for remaining mobile in their out-of-home environments. The accumulated body of evidence suggests that individual factors as well as multiple aspects of the built environment affect older people's potential out-of-home mobility and thus their capacity to participate in society. Driving status [11, 12], quality and availability of public transport [13, 14], and numerous other features of the built environment (see [15, 16]) are all implicated in this regard. Walkable environments are particularly important, given that neighborhood walking increases not only older people's opportunities for physical exercise but also social interaction [17]. Engagement in outdoor physical activity by older people is crucial to them remaining ambulatory and also provides numerous other health benefits [18].

In the United States, lack of physical activity among older people has been described as a major public health issue; the release of Surgeon-General's Report in 1996 indicated that less than one-third of adults aged 65 years and over met health recommendations of moderate intensity exercise (e.g., brisk walking) for 30 minutes, five or more days per week [19, S267]. More recent research conducted in New Jersey shows a similar pattern, with just 28.6 percent of 50- to

74-year-olds being found to meet exercise recommendations [20]. The proportion of older people who meet exercise guidelines has been shown to be highly variable, however, both within and between different countries. A systematic review of studies investigating physical activity among older adults (limited to those studies which reported their findings in terms of older people meeting exercise guidelines) revealed that this proportion ranges between 2.4 and 83.0 percent, with the majority of the 53 studies reviewed being found to report proportions of between 20 and 60 percent [21]. Only 6 of these studies (undertaken in the United States, Australia, the United Kingdom, Brazil, China, Canada, New Zealand, Columbia, South Africa, Greece, Cyprus, Sweden, and Switzerland) used an objective measure of physical activity (i.e., accelerometer), with the remainder being based on self-reported activity.

Research efforts over the past decade have provided insight into many features of the built environment that encourage or constrain older people's walking decisions. Yet, the extent to which older people's walking behavior actually differs as a function of the particular built environment in which they live remains unclear. Much of the research literature related to the built environment and walking activity is based on random samples, with findings being largely representative of those living in urbanized areas (i.e., similar built environments) [22]. In addition, the vast majority of available studies of walking behavior among older people are based on self-report, making the findings subject to bias (e.g., participant recall and selection of socially acceptable responses). A recent review of empirical literature that examined mobility or disability among older people and also utilized objective measures of the built environment [15] identified 17 studies published between 1990 and 2010 that met these criteria. Of these, 14 studies investigated walking behavior, with all but one [23] being based on self-reports of walking. Rosso et al. [15] concluded that although evidence of a direct relationship between the built environment and elderly walking behavior was lacking, of all of the features of the built environment investigated, high density of intersections, street and traffic conditions, proximity to destinations, and green space were the factors most likely to have a direct effect on older people's out-of-home mobility. Nevertheless, a study of the consumption patterns and mode of travel used by older people (via GPS tracking) for accessing goods and services within two different countries (suburbs of Canada and France) showed that older people in both locations were highly reliant on travel by motor vehicle, despite substantial differences in the built environment and availability of public transport in the two study sites [24]. This raises questions about the assumption that levels of walking outdoors among the older segment of the population will naturally follow modifications to the built environment that make them more "age-friendly," without a shift away from sedentary lifestyles and a change in the propensity of the elderly to rely predominantly on motor vehicles for movement outside of the home domain.

Older people have identified particular urban design features such as green and open spaces [25, 26] as being conducive to walking. Other features like poorly maintained pedestrian infrastructure and traffic, however, heighten their fears about personal safety [27]. Evidence suggests that these fears about safety are well grounded, given that most falls occur outside of the home domain with the majority taking place on curbs, sidewalks, and streets [28] and that older people are the most likely group to present at hospital for injuries sustained from pedestrian-cyclist collisions [29]. Unfortunately, however, fear of moving outdoors also increases older people's risk of diminished capacity to walk outdoors in the longer term. Longitudinal research has shown that older people who fear walking outdoors are 4.6 times more likely than those without this fear to develop difficulties in walking a distance of 0.5 kms [30]. Older people's personal expectations about aging also influence their walking behavior. A pilot test of a behavioral intervention aimed at altering belief in the inevitability of becoming sedentary as a consequence of the aging process demonstrated that older people not only increased their walking after intervention but also experienced multiple other benefits including ease in performing daily life tasks and improvements in mental health-related quality of life, pain, energy, and quality of sleep [31].

Meeting the objective of maximising people's opportunities for ongoing participation within society as they proceed into older age is likely to be a major challenge for policy makers in industrialized nations. Cross-country analyses (of Canada, Finland, Germany, Italy, Japan, the Netherlands, Sweden, the United Kingdom, and the United States) indicate that there is a remarkably similar pattern in the age profile of work and passive and active leisure activities across countries [32]. Despite considerable variation in hours spent doing paid work between countries for adults in the 45–54 age group, intercountry differences seem to vanish by the age of 75 years and over, with time that was previously spent doing paid work being predominantly reallocated to passive rather than active leisure activities [32]. Much of older people's time also appears to be spent at home. Research undertaken in Berlin with community-based and institutionalized adults aged 70 years and over, for example, indicates that older people spent the majority of their day alone at home (80% of awake time) and less than a fifth of their day outdoors (18.7%) [33]. Similarly, more recent Australian research indicates that only a small proportion of time is spent away from home (90.2% spent at home) by community-based adults aged 65 years and over, with the mean number of episodes spent away from home in the previous week being 6.3 (SD = 4.5; range 0–19) [34]. In addition, the average daily time spent away from home by older people who have had a stroke and those who have not appears to very similar (0.9 versus 1.1 hours, resp.) [34]. Age- and/or health-related issues are implicated, however, in a substantial difference observed in older Australians' engagement in volunteering. Twice as many current drivers (66%) as retired drivers (30%) reported involvement in this particular form activity [35].

The current study used a mixed-methods approach to explore areas of interest within the area of active aging that are currently underresearched, including (1) the connection between older people's self-perceptions of "being active" and indicators of their health and participation (domains which are proposed by the WHO to be two of the three key determinants of "active aging"); (2) older people's perceptions

of characteristics of their respective communities, which are generally conceived to facilitate aging in place; and (3) the extent to which older people's out-of-home physical activity differs across different built environments, based on high quality objective measures of active travel (walking and biking).

2. Materials and Methods

2.1. Participants and Study Locations. A convenience sampling method was used to recruit a total sample of 48 adults aged 55 years and over, comprising 4 subsamples of equal numbers ($n = 12$) of individuals living in (1) inner city suburbs and (2) suburbs outside the inner city area of a capital city, (3) a regional city, and (4) a rural town in Queensland, Australia. Recruitment took place via two methods. The first involved residents of inner city suburbs of Brisbane (within 5 kms of the central business district) who had participated in a previous project (Living in the City) and also indicated their willingness to be contacted for future research being invited to participate as representatives of high density living environments. Eleven were recruited. The second recruitment method involved key community organisations and groups being approached to assist in identifying potential participants living in Brisbane suburbs situated outside the inner city, Toowoomba (a regional city), and Roma (a rural town), as well as one individual to complete the Brisbane inner city subsample. Each individual was subsequently contacted via phone and/or email and invited to participate in the study. The total sample comprised 24 males and 24 females with each of the four subsamples being comprised of equal numbers of males and females (a thirteenth individual from Roma who volunteered to participate in the study jointly with her spouse was excluded from the study to ensure both an equal gender ratio and subsample size).

All participants were ambulatory and the age range for the whole sample was 56 to 93 years (average age of 72.02 years; SD = 8.46). Table 1 provides a demographic profile of the sample across the four study locations with respect to age, income, marital status, and current housing (derived from survey data). The population density for each of the four study locations is reported in the footnotes of the same table. The mean age for three of the subsamples was almost identical, but the mean age of the regional city (RC) subsample was between 2.5 and 2.7 years higher than the inner city (IC), city suburban (CS), and rural town (RT) groups. Nearly all of those from the IC group had high incomes, while the majority living in the CS, RC, and RT locations had incomes that fell in the low range. The most common source of income across the whole sample was the old age pension (33.3%), but superannuation also provided whole or part of the annual incomes of one-third of the sample. Only a small proportion of the whole sample was engaged in full- or part-time work (15.2%). The majority of participants in each subsample were married and also owned the homes in which they resided. All members of the IC group were living in a flat or unit (interview data revealed that most lived in a unit), while the majority of the other three subsamples were living in a house. Most of the older people in each of the four study locations owned their own dwelling.

2.2. Data Collection. Quantitative data were gathered from a GPS device (which captured one logged position every one minute and was used to track all out-of-home travel over seven consecutive days) as well as responses to a brief survey contained in the front section of a travel diary. The GPS device, GPS charger, and diary were posted to each participant, which they returned to the project site by post or courier at the end of the tracking period. Qualitative data were obtained from daily travel diary entries made by each participant (documenting all out-of-home travel, activities undertaken outside the environment, and the mode of transport used for each trip). In a few cases, participants forgot to either recharge their GPS device or take the device when they left home on one or two days and so were asked to continue completing their travel diaries and using the GPS to ensure that their out-of-home travel was monitored for the required seven days. Following the return of the completed diaries, GPS device, and charger, the GPS data were converted into individual time/space maps for each participant using Google Earth software. Diary entries were used to color-code each trip line shown on the maps to indicate the means of travel used for each trip made (by car, bus, ferry, train, taxi, and bicycle and on foot). These maps were subsequently used to direct discussion and verify correspondence between the GPS data and diary entries during in-depth, semistructured interviews held with each participant approximately two weeks after the tracking period. Interviews lasted approximately 90 minutes on average. Approval for this study was given by the QUT Human Research Ethics Committee.

2.3. Measures

2.3.1. Survey Data. Survey items tapped demographic characteristics (see Table 1) as well as attributes of the built environment in which participants lived. The latter were assessed from endorsement of statements that represented reasons for them living in their current community and included proximity to destinations (it is close to shops, etc., and close to my family/friends) and safety (it is a safe area). Participants' perceptions of the age-friendliness and disability-friendliness of their communities were captured by responses to two separate items with a shared lead-in question ("Do you think your community is: (1) "age-friendly"; and (2) "disability-friendly". Available options were the same for each item ("yes", "no", "do not know", and "never thought about it"). Self-perceptions of being healthy and being active were tapped from responses to two single-item, five-level Likert scales (options and coding for these variables are reported in Table 3). Survey forms also included a question asking about all modes of transport normally used for moving around one's neighbourhood (for details of survey item and available options, see footnotes of Table 4).

2.3.2. GPS and Travel Diary Data. Travel diary entries were used in conjunction with GPS data for determining the

Table 1: Demographic profile of participants by study location.

	Inner city[a] ($n = 12$)	City suburban[b] ($n = 12$)	Regional city[c] ($n = 12$)	Rural town[d] ($n = 12$)	Totals (%)
Age (in years)					
Range	56–80	57–87	68–93	59–88	N/A
Mean	72.3	72.3	75.0	72.4	N/A
Annual income					
Low ($40k and below)	1	9	8	8	26 (54.2)
Mid ($40k–$70k)	1	2	3	—	6 (12.5)
High ($70k and over)	7	1	—	—	8 (16.7)
No response	3	—	1	4	8 (16.7)
Source of income					
Wage	3	1	1	1	6 (12.5)
Superannuation	3	3	1	—	7 (14.6)
Part superannuation	—	—	1	—	1 (2.1)
Pension	4	5	7	—	16 (33.3)
Part pension	1	—	—	1	2 (4.2)
Part super/part pension	3	3	2	—	8 (16.7)
Self-funded	2	1	1	—	4 (8.3)
Self-employed	—	—	—	3	3 (6.3)
No response	—	—	1	—	1 (2.1)
Employment					
Full-time	2	—	1	1	4 (8.3)
Part-time	1	1	1	—	3 (6.3)
Not employed	9	10	10	10	39 (81.3)
No response	—	1	—	1	2 (4.2)
Marital status					
Married	7	6	9	10	32 (66.7)
Separated	—	—	—	1	1 (2.1)
Widowed	2	1	—	1	4 (8.3)
Not married	3	5	3	—	11 (22.9)
Dwelling type					
Flat/unit	12	2	1	1	16 (33.3)
Duplex	—	—	1	1	2 (4.2)
Townhouse	—	—	—	1	1 (2.1)
House	—	10	10	8	28 (58.3)
Room	—	—	—	1	1 (2.1)
Owns current dwelling					
Yes	11	9	10	11	41 (85.4)
No	1	3	2	1	7 (14.6)

[a]IC location includes six statistical local areas (SLAs) in the capital city of Brisbane (total population in 2010 = 1,067,290); average population density of the six SLAs = 4,193.6 persons per km^2.
[b]CS location includes 12 SLAs in Brisbane; average population density (in 2010) = 1,912.7 persons per km^2.
[c]RC location is 127 kms west of Brisbane; total population in 2010 = 131,258; population density = 236.8 persons per km^2 (based on statistical subdivision of Toowoomba).
[d]RT location is 420 kms west of Brisbane; total population in 2010 = 7,156; population density = 96.6 persons per km^2 (based on SLA known as Maranoa, Roma, under statistical subdivision South West in Queensland).

number of days when participants ventured out of home, their use of public transport, time spent travelling on foot and by bicycle outside of the home environment, and the total time spent traveling outside home over the seven-day tracking period. In combination, travel diary entries and GPS tracking produce high quality data on travel behavior [36]. A new variable was created which measured the total time spent travelling on foot and by bicycle to ensure that all of participants' travel by active means over the tracking period was captured.

The continuous variables for time spent walking and travelling by active means were converted into a six-level

Table 2: Participants' perceptions of their respective communities.

	Inner city ($n = 12$)	City suburban ($n = 12$)	Regional city ($n = 12$)	Rural town ($n = 12$)	Totals (%)
Age-friendliness of community					
Yes	7	6	8	10	31 (64.6)
No	—	2	2	1	5 (10.4)
Do not know	—	2	2	—	4 (8.3)
Never thought about it	4	2	—	1	7 (14.6)
No response	1	—	—	—	1 (2.1)
Disability-friendliness of community					
Yes	3	3	6	8	20 (41.4)
No	2	4	1	1	8 (16.7)
Do not know	3	3	3	—	9 (18.8)
Never thought about it	2	1	—	2	5 (10.4)
No response	2	1	2	1	6 (12.5)
Community features					
It is close to my family/friends	3	3	7	3	16 (33.3)
It is close to shops, etc.	4	3	4	3	14 (29.2)
It is a safe area	5	2	4	5	16 (33.3)

measure of 30-minute intervals (ranging from zero to a maximum of over 2 hours) for the purpose of correlational analysis because of the wide variation in minutes travelled on foot and walking/biking by those who walked or used active means for a period of more than two hours. Travel time captured by GPS in off-road open spaces (such as parks and golf courses) was included, but any time spent inside buildings (such as shopping centers) was excluded from travel calculations.

2.4. Analysis. All of the analyses were undertaken using SPSS 21.0. Cross tabulations were run for individual categorical and ordinal variables for descriptive purposes. Results are reported in tables in the form of cell counts due to the small size of each subsample, with percentages being shown in the totals column of each table. Missing values are reported in the tables (as "no response") and are included in the row totals.

Pearson correlation analyses were performed to identify relationships between select variables for the entire sample for exploratory purposes to determine relationships between self-perceptions of being active and being healthy and objective measures of participation (number of days when participants travelled out of their homes) and travel by active means outside the home environment. Comparative analyses of the four study locations were undertaken using a non-parametric approach, the Kruskal-Wallis test of significance, due to its appropriateness for three or more independent, small, and nonrandom samples. The statistical significance of differences between groups determined by this test is based on ordinal information only, with observations being ranked and the mean rankings of the various groups being compared [37]. The original continuous variable minutes spent walking and minutes spent walking/biking were used for these analyses to ensure true ranking of data (actual minutes) and minimization of tied ranks.

3. Results and Discussion

3.1. Results

3.1.1. Older People's Perceptions of Their Communities Being Age- and/or Disability-Friendly. Table 2 shows that the majority (64.6%) of the whole sample believed that their communities were "age-friendly" but less than half (41.4%) agreed that they were "disability-friendly." Interestingly, a similar proportion (41.7% in total) neither agreed nor disagreed about the disability-friendliness of their communities and either "did not know" (18.8%), had "never thought about it" (10.4%), or did not respond to the question (12.5%). More individuals within the RC and RT subsamples rated their communities as being age- and disability-friendly than the two capital city subsamples (IC and CS).

3.1.2. Perceived Attributes of the Community. Participants' reasons for living in their current community are shown in the lower part of Table 2. One-third of the whole sample identified their respective communities as being safe areas (33.3%) and similar proportions reported proximity as a factor that contributed to their reasons for living in their current communities ("close to family/friends" = 33.3%; "close to shops, etc.," = 29.2%). More older people living in the RC location identified being close to family/friends than those in the IC, CS, and RT groups (7 versus 3) as a reason for living in their current community, while similar numbers selected "being close to shops, and so forth." Only two older people living in the CS area agreed that safeness of the area was a reason for them living in their communities (compared to 4 or 5 in the other three groups).

3.1.3. Self-Perceptions of Being Healthy and Active and Participation outside Home. The patterns of self-ratings of being

Table 3: Self-ratings of being healthy and of being active and days ventured out of home over a seven-day period.

	Inner city ($n = 12$)	City suburban ($n = 12$)	Regional city ($n = 12$)	Rural town ($n = 12$)	Totals (%) ($N = 48$)
Being active[a]					
Very inactive	1	—	—	—	1 (2.1)
Inactive	1	—	—	—	1 (2.1)
Somewhat active	3	4	4	3	14 (29.2)
Active	6	4	6	7	23 (47.9)
Very active	1	4	2	2	9 (18.8)
Being healthy[b]					
Very unhealthy	—	—	—	—	—
Unhealthy	1	3	2	1	7 (14.6)
Okay	2	2	—	5	9 (18.8)
Healthy	5	4	8	5	22 (45.8)
Very healthy	4	3	2	1	10 (20.8)
Number of days ventured out of home[*]					
Two	1	1	—	—	2 (4.2)
Four	1	1	—	1	3 (6.3)
Five	—	2	4	1	7 (14.6)
Six	4	2	5	4	15 (31.3)
Seven	6	6	3	6	21 (43.8)
Mean (overall mean = 6.00)	6.00	5.83	5.92	6.25	N/A
Median (overall median = 6.00)	6.50	6.50	6.00	6.50	N/A

[a]Survey item: "think about the things you do during an average week. How active would you describe yourself to be?"; coding: 1 = very inactive; 2 = inactive; 3 = somewhat active; 4 = active; 5 = very active.

[b]Survey item: "how healthy are you?"; coding: 1 = very unhealthy; 2 = healthy; 3 = okay; 4 = healthy; 5 = very healthy.

[*]Number of days ventured out of home significantly related to self-ratings of being active at $P = <0.05$.

active and of being healthy were each found to follow a normal distribution with a left skew (prone to being healthy and active), results that are to be expected for a community-based older sample. The majority rated themselves as being either "very active" (18.8%) or "active" (47.9%), and just under one-third of the sample considered themselves to be "somewhat active" (29.2%). Only two identified themselves with inactivity (one selected "inactive" and the other "very inactive"). A majority also perceived themselves to being either "very healthy" (20.8%) or "healthy" (45.8%). Less than one-fifth rated themselves as "unhealthy" (14.6%) and none of the participants reported being "very unhealthy" (see Table 3).

No relationship was found to exist between self-ratings of being active and self-rated health status ($r = 0.24$; $P = 0.098$). Self-perceptions of being active were also found to be unrelated to age ($r = -0.15$; $P = 0.317$), but a statistically significant, negative correlation was found between self-rated health status and age ($r = -0.32$; $P = 0.027$).

Only five of the total sample of 48 travelled outside of their home in four days or less over the monitored week. The number of days on which participants ventured out of home was positively associated with their self-ratings of being active ($r = 0.36$; $P = 0.011$) but was unrelated to both self-ratings of health ($r = 0.11$; $P = 0.468$) and age ($r = -0.26$; $P = 0.072$), and the subsample means and medians for days travelled outside home were remarkably similar (see Table 3).

3.1.4. Out-of-Home Travel Using Active Means. The first part of Table 4 summarizes self-report travel-related information derived from survey to provide context to the GPS tracking results for time actually spent walking and walking/biking combined. The vast majority (81.3%) reported being drivers of a motor vehicle. Most drove cars but one person drove a motorcycle and another two drove both a car and a motorcycle. Another six (12.5%) travelled by motor vehicle as a passenger, and only three reported that they did not travel by motor vehicle (as either drivers or passengers). Less than half (41.7%) of the whole sample reported ever using public transport, and all but one of this group were from the IC and CS locations. None of the RC sample reported using public transport even though bus services are available in their location. Both the RC and RT locations only have access to train travel for the purpose of traveling outside of their local areas (rail link extends eastbound to Brisbane and westbound to Charleville), and only one participant from the RT group reported ever using the train. GPS data showed that only a quarter (25.0%) of the sample actually used public transport during the tracking period.

The actual time spent walking and time spent walking and biking combined by individuals living within the four study locations (based on GPS data) are shown in the lower section of Table 4. With respect to walking, one-third of the whole sample did not travel on foot out of their home environments at all over the tracking period. Considering this group and the

Table 4: Self-reported travel modes ever used and time spent walking and using active means of travel over a seven-day period.

	Inner city ($n = 12$)	City suburban ($n = 12$)	Regional city ($n = 12$)	Rural town ($n = 12$)	Totals (%)
Self-reported modes of travel ever used[a]					
Walking	10	8	6	10	34 (70.8)
Bicycling	1	2	—	1	4 (8.3)
Public transport	9	10	—	1	20 (41.7)
Motor vehicle					
Car as driver only	7	7	5	5	24 (50.0)
Car as driver or passenger	3	2	4	3	12 (25.0)
Car as passenger only	2	1	2	1	6 (12.5)
Driver of motorcycle	—	—	1	—	1 (2.1)
Driver of car and motorcycle	—	—	—	2	2 (4.2)
Neither driver nor passenger	—	2	—	1	3 (6.3)
Actual travel by public transport over seven days					
Bus	2	5	1	1[b]	9 (18.8)
Train	—	2	—	—	2 (4.2)
Ferry	3	1	N/A	N/A	4 (8.3)
Total number using public transport[c]	4	6	1	1[b]	12 (25.0)
Time walked over seven days in categories					
Nil	3	6	3	4	16 (33.3)
1–30 mins	—	1	3	1	5 (10.4)
31–60 mins	2	1	1	2	6 (12.5)
61–90 mins	1	1	1	—	3 (6.3)
91–120 mins	2	—	1	—	3 (6.3)
>2 hrs	4	3	3	5	15 (31.3)
Actual minutes walked					
Range	0–586	0–790	0–293	0–590	N/A
Mean rankings (Kruskal-Wallis test)[d]	26.38	21.92	23.46	26.25	N/A
Time spent walking/biking over seven days					
Nil	3	3	2	3	11 (22.9)
1–30 mins	—	2	4	2	8 (16.7)
31–60 mins	2	1	1	2	6 (12.5)
61–90 mins	1	1	1	—	3 (6.3)
91–120 mins	2	1	1	—	4 (8.3)
>2 hrs	4	4	3	5	16 (33.3)
Actual minutes using active means of travel					
Range	0–960	0–1562	0–293	0–590	N/A
Mean rankings (Kruskal-Wallis test)[d]	25.67	25.42	22.04	24.88	N/A
Proportion of total time travelled by active means					
Range	0–83.0	0–100.0	0–77.0	0–76.3	N/A
Mean rankings (Kruskal-Wallis test)[b]	26.08	24.83	22.33	24.75	N/A

[a]Survey item: "how do you get around? Tick all that apply"; options: I walk; I use a bicycle; I drive myself with a . . . [car, motorcycle, motored wheelchair, or mobility scooter]; someone else drives me: [my partner, my children/grandchildren, community members, social or senior services, or taxi]; I use public transport [bus, train, or ferry].

[b]Travelling by private bus, as there is no public bus service in Roma.

[c]Only 12 individuals used public transport as some used more than one mode during the tracked seven days.

[d]No statistically significant difference between groups at $P = <0.05$.

next two categories (1–30 mins and 31–60 mins), more than half (56.2%) of the whole sample travelled out of home on foot for an hour or less during the monitored week. Just under one-third (31.3%) travelled on foot for more than two hours over the seven days. No correlation was found between time spent walking and self-perceptions of being active ($r = 0.12$; $P = 0.401$) and being healthy ($r = 0.12$; $P = 0.414$) or age ($r = -0.06$; $P = 0.688$).

In Table 4, it can also be seen that the number of nonwalkers in the lower density suburbs of Brisbane was

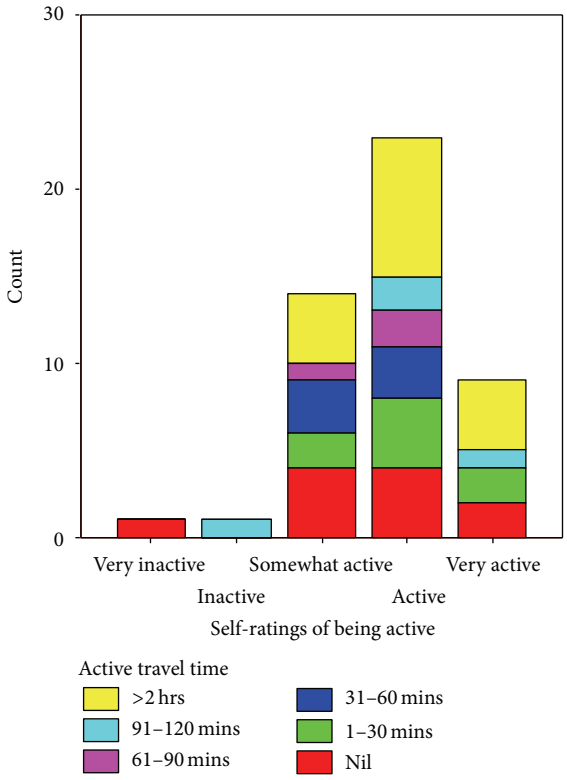

Figure 1: Active travel time by self-perceptions of "being active."

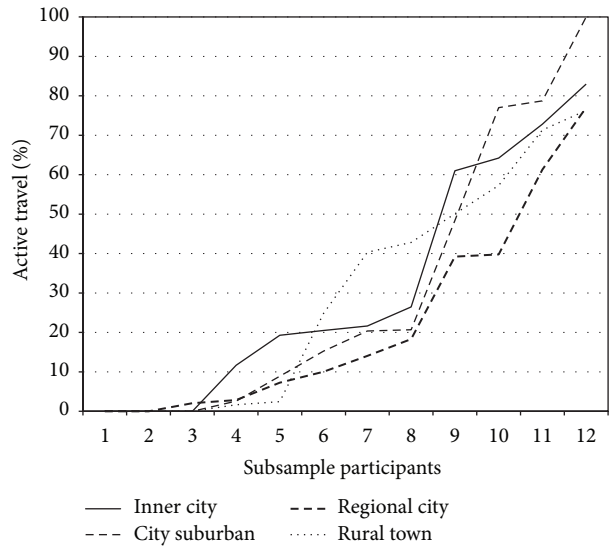

Figure 2: Proportion of total time travelled using active means over seven days by study location.

twice that of their counterparts living in the inner city suburbs of Brisbane, with the numbers of nonwalkers in the IC group being similar to both the RC and RT groups. Considering the actual time spent walking (in minutes) by each individual across each of the four groups, however, the Kruskal-Wallis test indicated there was no significant difference in the mean rankings by study location ($H(3) = 0.892$; $P = 0.827$).

Once time spent traveling by bicycle was taken into account, only three individuals in the CS group were found to have spent no time using active means of travel (on foot or biking), but the remainder of the findings were similar to those observed for walking. Time spent travelling by active means was found to be unrelated to both self-ratings of being active ($r = 0.16$; $P = 0.279$) and healthy ($r = 0.18$; $P = 0.216$) and to age ($r = -0.16$; $P = 0.284$). No significant difference between the four study locations was identified in the mean rankings of active travel (based on actual minutes) either ($H(3) = 0.520$, $P = 0.915$).

A visual representation of the lack of correlation between self-perceptions of being active and use of active means of travel is shown in Figure 1. Note, for example, that self-ratings of being active among those who spent no time walking or biking are distributed across four categories, from "very inactive" to "very active." A visual representation of the proportion of all time travelled over the tracking period spent using active forms of transport is shown in Figure 2. The similarity in the overall pattern that emerged for each of the four study locations is clearly evident and the Kruskal-Wallis test confirmed that there was no significant difference in the mean rankings of the proportion of overall time spent travelling by active means across the four study locations ($H(3) = 0.457$, $P = 0.928$).

4. Discussion

Overall, the findings contribute to a relatively small but growing empirical literature focused on active aging, by way of whole sample analysis and equal-sized subsample comparison. They add value to this body of evidence in five main ways. Firstly, the whole sample analyses enabled determinations to be made about the distribution of self-ratings of being active among community-based adults living in Australia. Like Bowling's [7] study undertaken in the United Kingdom (based on a larger sample than the current study), the most common self-rating for being active was the fourth level of a five-level single-item Likert scale ("active" in this study and "fairly actively" in Bowling's study). However, while the second most common rating in Bowling's [7] study was the fifth-level option "very actively," our research found the third-level option "somewhat active" to be the second most common, followed by "very active." This difference may be attributable in part to the wording and response options used by each study but may reflect either true difference in activity levels between older people in the United Kingdom and Australia or difference in the benchmark used by older people in these two nations when making this form of self-assessment. Replication studies of Bowling's [7, 10] research are needed in Australia and elsewhere in order to further understand older people's perceptions about the key constituents of active aging from their own perspective if we are to gauge similarities and differences across different cultures and countries.

Secondly, the current study was able to investigate correlates of self-ratings of being active beyond those examined by previous studies. Our finding that age was unrelated to

self-ratings of "being active" is consistent with Bowling's [7] study. Our finding that self-rated health status was unrelated to self-perceptions of being active differs however. Bowling [7] found a strong positive association between them. This inconsistency may rest on the nature of the sample used in the current study, whereby three-quarters were recruited through community organisations (and thus were actively participating in community activities) and around two-thirds reported being "healthy" or "very healthy" or differences in the measure of health status used in each study (Bowling's study used presence of a "limiting longstanding condition or disability" while this study used self-rated health status). The negative correlation we found between age and self-rated health is consistent with previous research showing an association between increasing age and more chronic health problems and declining functional ability [8].

Thirdly, this study had the capacity to explore whether self-ratings of "being active" were connected with actual behavior. The fact that these self-ratings were positively correlated with the number of days when time was spent out of home but unrelated to levels of out-of-home physical activity raises the possibility that older people in this study have embraced the idea that "active aging" is primarily about one's current participation within society. Future research efforts need to be directed at exploring the degree that self-assessments of being active as people age correspond with objective measures of both participation and outdoor physical activity. Active aging objectives are unlikely to be met if a gap exists between the meanings ascribed to active aging by older people and their actual behavior with respect to the latter. More than half of the sample (all ambulatory and mostly healthy) spent a daily average of between zero and 8.6 minutes walking outside of home over seven days. If this level of outdoor physical activity is representative of these participants' normal pattern of walking outdoors, their long-term prospects of remaining ambulatory and capable of performing daily life activities could potentially be compromised, with this in turn eventually undermining their capacity for living independently, aging in place, and participating in society. Our finding that less than one-third of older people in this study had walked for more than 2 hours over seven days is consistent with findings from studies undertaken in the United States [19, 20], where a similar car culture to Australia's prevails. Given the accumulated evidence about barriers to walking (see [16, 27]) and the difficulties associated with using public transport [14] experienced by older people, as well as this group's reliance on cars [12, 24], it may be that the developments of community-based programs that encourage walking behavior among older people with a specific focus on recreational walking in spaces where pedestrian infrastructure is in good condition and free of traffic (e.g., parks and cyclist-free pedestrian walkways) are needed. These programs could target individuals as well as groups (such as senior citizens organizations) and may require the use of motorized transport (e.g., private motor vehicles and public or private bus) for gaining access to well-maintained, safe walking tracks. This approach could potentially create opportunities for older people to overcome their fears about moving outdoors, increase their number of social interactions [17], maintain or improve their overall health and well-being through the gaining of regular exercise [18, 31], and also change expectations that an increasingly sedentary life is a natural part of the aging process [31].

Fourthly, this study was able to explore whether different built environments (with varying public transport services and population densities) were associated with higher or lower levels of active travel. While the lack of difference in time spent walking (or walking/biking combined) between locations observed in this study could potentially be due to the size of the groups in the subsample, there is no reason to suspect that this particular finding is simply spurious in nature. We were able to gather a range of information about each location, including older people's perceptions of the age- and disability-friendliness of their respective communities, their safeness and closeness to amenities and family/friends, and differences in public transport services. Interestingly, similar numbers of participants in each location identified being "close to shops, and so forth" as a reason for living in their current communities. Thus this particular feature of the environment was not one that differentiated the inner city subsample from the other three lower density areas, even though higher density areas are often touted to be places that provide greater and easier access to amenities, goods, and services than lower density areas. Previous research indicates that it is proximity to particular destinations (especially shopping malls, retail outlets, and places of employment) and not population density that is associated with the walking behavior of older people (see [15]). Despite differences in public transport services in each study location and in older residents' perceptions of the age- and disability-friendliness of their respective communities, the emergent pattern of the proportion of time traveled by active means over seven days by older people was remarkably similar. This along with the finding from the whole sample analysis that only one-third engaged in active travel for more than two hours, a proportion that is consistent with findings from large population studies of older people's walking behaviour [19, 20], raises the possibility that variability in the walking behavior of older people has more to do with normal variation within populations (as a consequence of numerous factors) than it does to features of the surrounding environment. Together with the absence of any convincing evidence that there is a direct relationship between the built environment and older people's walking behavior [15] and the many barriers identified in the extant empirical literature which deter older people from venturing out of home on foot, our study's findings give grounds for questioning any taken-for-granted assumption that older people will walk outdoors more frequently if the surrounding environment is made more "walkable." A universal approach may need to be taken with respect to the provision of community-based walking programs for older people (discussed earlier) to ensure they are widely available, irrespective of the nature of the surrounding built environment of their homes, if a substantial increase in the outdoor physical activity of this segment of the population is to be achieved.

Fifthly, the mixed-methods approach used in this study provided the opportunity to explore connections between

self-ratings of being active and objective measures of physical activity outside of the home domain via GPS tracking, as well as comparison of physical activity across four different settings that differ by population density and built environment (including public transport services). This combination of methods represents a major strength of our study. The capturing of time spent biking is an additional strength of this study, since research that relies on walking behavior alone ignores physical activity undertaken through alternative means. By instructing participants to document all modes of transport used for their out-of-home travel in combination with GPS tracking, this research avoided the circumstance where the research process itself leads participants to modify their walking behavior. This is a limitation of studies based on accelerometer-based information, the results of which do not necessarily reflect people's usual pattern of walking, because participation procedures (i.e., wearing an accelerometer) potentially prompt individuals to walk more frequently than normal for the monitored period.

Finally, further research based on objective measures of walking (as well as larger samples recruited from urban and rural settings) is needed if evidence-based determinations are to be made about the extent to which particular built environments foster greater levels of walking among older people (as proposed by Giles-Corti et al. [22]). The constraints imposed on the size of this study's sample by the nature of its methodological approach may be averted by future studies, given that technological advancements in recent years are making this approach increasingly feasible for larger samples. The developments of digital diaries, which are able to be used by participants at the same time and on the same device as GPS tracking takes place, hold great promise in their capacity to streamline data collection of movement and activity information, as well as data management and analysis, and may also reduce participant burden (see Draijer et al. [36]). Whether or not these new devices are useful for older samples (who may resist making diary entries in a technological device in place of paper and pencil diaries) remains to be seen however. The high quality of data produced by GPS/travel diary methods suggests significant benefits could accrue from the trialing of these new technologies with older samples. If successful, substantial headway could be made in expanding the body of evidence on the relationship between the built environment and older people's walking behavior gathered from high quality measures of walking.

5. Conclusions

Given that "active aging" is being promoted as a key policy agenda for dealing with the growing aging populations in industrialized nations, this particular subject area warrants much greater attention than it has attracted to date. It is imperative that older people understand the nature of all the constituents of the active aging concept as outlined by the WHO [1] if the objectives of its policy framework are to be met. Currently, evidence related to the meanings older people ascribe to this concept as well as the particular constituents of active aging that inform this group's self-ratings of being active is limited. More research is needed to determine if older populations are prone to connect "active aging" with "getting out and about and doing things" in the present more than they do behaviors such as walking outdoors as a means to maintain their health into the future. "Active aging" is extremely broad in scope compared to its conceptual predecessors ("successful," "healthy," and "productive" aging). It may therefore be necessary for messages communicated to the public under the banner of "active aging" to clearly articulate and emphasize the need for physical activity as a means to maintain health and prolong older people's participation within society. Furthermore, the flurry of research interest in the relationship between the built environment and older people's walking behavior that appears to have been sparked by the WHO's [2] Global Age-Friendly Cities publication has not been matched by similar interest in other areas pertaining to active aging. Researchers and policy makers alike need to remain mindful that the built environment is just one of many factors affecting older people's opportunities to age actively and that modifications to the built environment may be insufficient to the task of overturning older people's unwillingness to move outdoors on foot through fear of falls and injuries from traffic and poorly maintained pedestrian infrastructure, their expectations about aging, or the perceived comfort and convenience of the motor vehicle.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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Research Article

Leisure Engagement: Medical Conditions, Mobility Difficulties, and Activity Limitations—A Later Life Perspective

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Objectives. This study aims to investigate the impact of medical conditions, mobility difficulties, and activity limitations on older people's engagement in leisure activities. *Methods*. The analyses are based on a cross regional survey carried out in 2010 in the Bothnia region (Northern Sweden and Western Finland). A posted questionnaire, which included questions on different aspects of leisure engagement, medical history, and health, was sent out to older persons in the region. The final sample consisted of 5435 persons aged 65, 70, 75, and 80 years. The data was analyzed by using ordinary least squares (OLS) multivariate regression. *Results*. The most important predictor of leisure engagement abstention among older people is the prevalence of activity limitations, whereas mobility difficulties and medical conditions play less important roles. The strong negative association between activity limitations and leisure engagement remains significant even after we control for individual, sociodemographic characteristics, and country. *Discussion*. This study provides a window into leisure engagement in later life and factors influencing the magnitude of engagement in leisure activities.

1. Introduction

Older people's participation in leisure activities, such as involvement in cultural, social, and physical activities, is known to be positively associated with health and survival [1]. It is therefore important to improve the understanding of the risk factors that might cause a decline in such participation. Accordingly, this study aims to investigate the impact that health-related risk factors, such as medical conditions, mobility difficulties, and activity limitations, may have on older people's engagement in leisure activities.

European countries are currently facing major demographic changes due to substantial increases in longevity (a large reduction in late life mortality) and declines in fertility [2, 3]. As a consequence, the number and proportion of older people will increase. This fact has led to a growing interest in understanding how to meet the needs of an ageing population. It is also a public health priority that includes, among other things, the identification of components that can promote factors to support active and healthy ageing [4, 5]. In an aging population, the prevalence of health-related risk factors such as medical conditions, mobility related difficulties (limits in functions), and activity limitations (inability to perform activities) increase with age [6]. The relation between the above-mentioned health-related risk factors and health is, however, complex and much discussed [7]. According to the World Health Organization, health is a state of complete physical, mental, and social well-being, and to reach this state we must be able to identify and realize aspirations in life, satisfy our needs, and be able to change or cope with the environment [8]. Therefore, the relationship between engaging in activities and becoming healthy is an important perspective of health [9] with a long history [10].

On a general level, engagement in leisure activities has demonstrated positive health-related outcomes [11] and correlates explicitly with increased survival and life expectancies

[12], lower mortality rates [13–17], and higher levels of happiness [18, 19]. Engagement in leisure activities seems therefore to be an important health promoter in the case of older people [17]. Engagement and participation in leisure activities are reported slowly decline over time in later life [20, 21], but how this decline can be promoted is less known. Participation in leisure activities is often studied from the aspect of performing activities as such, while some studies also highlight the importance of incorporating the purpose or motivational aspects for added understanding [22, 23]. Being motivated is a crucial component for making the leisure activities meaningful [11], and therefore the motivation component is an important factor to take into account when conducting research on leisure engagement and its relation to health-related conditions.

Earlier research has shown that functional decline could be an important indicator of ill-health in later life [24, 25]. However, according to the World Health Organization [26], functional decline and limitations might not be the direct cause of the limited ability to perform activities, as the adaptation to the environment or by the person could reduce the negative effect of such decline. Hence, understanding the cause to activity limitations is complex; Wu et al. [27], for example, did not find any associations between medical diseases and activities of daily living (ADL), whereas Gill et al. [24] found change in physical performance as independently associated with ADL dependency. While maintaining healthy habits is described as preventing the deterioration of functional capacity [28, 29], few studies focus on leisure engagement as a result or indicator of a person enjoying good health. Atchley [30] found that limitations in performance affected leisure patterns in older people, but if and how this is true also for mobility difficulties and other important health-related risk factors in later life needs further investigation.

In this study, we therefore wanted to explore potential health-related risk factors related to leisure engagement decline by studying the impact of medical conditions, mobility difficulties, and activity limitations in relation to leisure engagement. While studying this relation, it is important to consider the influence of personal characteristics upon these relationships. For example, it is known that later life health problems seem to vary between genders [31], to be influenced by socioeconomic aspects, and to vary between countries or geographic regions [32]. Therefore, these potential confounders must be considered as having a possible impact on this relation. Specifically, the research questions for this paper are the following.

(1) Is there a relationship between medical conditions, mobility difficulties, activity limitations, and leisure engagement in older people?

(2) Is the relationship influenced by sociodemographic aspects such as gender, age, economy, and geography?

2. Data and Methods

2.1. Sample. The analyses are based on a cross regional survey carried out in 2010 as a part of an interregional EU-funded research project (Gerontological Regional Database and Resource Centre, GERDA). The overall aim of the multidisciplinary project was to map living and health conditions of older adults (aged 65, 70, 75, and 80 years) in the Bothnia region, that is, on both sides of the *Gulf of Bothnia*, in *Västerbotten* in Sweden and in *Österbotten/Pohjanmaa* in Finland (more information about the project is available at the project website (http://web.novia.fi/gerda/)). Although the two regions *Österbotten* and *Pohjanmaa* belong to the same geographical region, they can in fact be treated as two separate regions due to different linguistic conditions (the (technical) division between *Österbotten* and *Pohjanmaa* relates to a language stratification of citizens in this particular West-Finnish region. Elderly Swedish-speaking inhabitants were coded as belonging to *Österbotten* and those with Finnish as their mother tongue were coded as belonging to *Pohjanmaa*). In this paper, however, we do not separate these two areas from each other, since the linguistic characteristics of the Finnish population are controlled for by the language variable.

In 2010, the Swedish region *Västerbotten* consisted of 15 municipalities, including two more densely populated areas (*Umeå* and *Skellefteå*), with an overall population of approximately 260,000 inhabitants. The overall population in the West-Finnish region *Österbotten/Pohjanmaa* (including the town of Vaasa) consisted of approximately 178,000 inhabitants [33]. Although the above-mentioned regions share several common structural features, such as common cultural characteristics and common historical bonds, there are also noticeable differences between them, such as differing linguistic conditions. Finland is an officially bilingual state with a large Finnish-speaking majority and a small Swedish-speaking minority of approximately 6 percent. However, in *Österbotten/Pohjanmaa,* 51 percent of the population belong to the Swedish-speaking group and form to some extent a majority at the local level. In 2010, three out of 17 municipalities in *Österbotten/Pohjanmaa* were officially monolingual (Finnish) whereas Swedish-speakers formed the local majority in nine municipalities. The two language groups in Finland were sent questionnaires in their own language.

A total sample of 10,696 was selected from the National Tax Board in Sweden and the Population Register Centre in Finland. Questionnaires were sent to all people that in 2010 were 65, 70, 75, and 80 years old in rural municipalities, to every second person in the most populous town in Finland and to every third person residing in the two most populous towns in *Västerbotten*. In total, 6 838 persons (64%) replied. The response rate varied between the regions, with 70% responding in *Västerbotten*, 62% in *Österbotten,* and 53% in *Pohjanmaa*. The response rate decreased marginally with age. The response rate was somewhat higher amongst the two younger age groups (66%) than those aged 75 and 80 years (61.9 and 59.2%, resp.).

In order to be selected as a part of the sample, valid responses on leisure engagement were required. This criterion narrowed the final sample down to a total of 5435 older persons. A description of the sample is found in Table 1.

2.2. Data Collection. A posted questionnaire was sent out during late 2010 and included a broad range of questions

Table 1: Frequencies (%) of basic characteristics in the studied sample.

	Total sample $n = 5435$	Finland $n = 2220$	Sweden $n = 3215$
Age			
65	2185 (40.2)	965 (43.5)	1220 (37.9)
70	1357 (25.0)	508 (22.9)	849 (26.4)
75	1091 (20.1)	449 (20.2)	643 (20.0)
80	800 (14.7)	298 (13.4)	502 (15.6)
Gender			
Women	3018 (55.5)	1259 (56.7)	1759 (54.7)
Men	2416 (45.5)	961 (43.3)	1455 (45.3)
Living condition			
Single living	1401 (26.0)	517 (23.5)	884 (27.8)
Living together	3983 (74.0)	1686 (76.5)	2297 (72.2)
Education level			
Shorter (up to 9 yrs)	2469 (46.4)	925 (42.3)	1544 (49.1)
Longer (10 yrs or more)	2857 (53.6)	1255 (57.6)	1602 (50.9)
Income level			
≤1000€	1384 (27.2)	599 (28.3)	786 (26.5)
>1000€	3700 (72.8)	1515 (71.7)	2185 (73.6)
Leisure engagement			
M (SD)	0.28 (0.99)	0.29 (0.97)	0.27 (1.0)
Range	−4.90–5.10	−4.90–5.0	−4.60–5.10

related to aspects of societal engagement, medical history, health, and sociodemography. The battery of questions was developed by the multidisciplinary team of researchers included in the GERDA, and for this paper we analyzed medical conditions (integrating ≥5 pharmaceutical drugs, stroke, heart disease, cancer, and hospital stays during the last 12 months into an index); mobility difficulties (integrating fear of falling and mobility device into an index); activity limitations (integrating independent bathing and independent cleaning into an index); and leisure engagement. The sociodemographic variables included in the analysis were age (65/70/75/80 yrs), language (Swedish/Finnish and other languages), gender (man/women), civil status (single/together), income (≤1000€/>1000€), education (≤9 yrs/≥10 yrs), and country (Finland/Sweden).

Leisure engagement was measured by asking about two aspects of 20 different leisure activities (task): first if the participant had a habit of performing the task and then if the participant was motivated to perform the said task. These questions were a part of the MNPS leisure checklist that has been used in previous similar samples and that has been evaluated for its validity [23, 34].

2.3. Data Analysis. Firstly, we calculated the extension of medical conditions, mobility difficulties, and activity limitations in every person by adding up each component in the index into a number. More specifically, each person was assigned a number that put their medical condition between 0 and 5 based on if they reported using ≥5 pharmaceutical drugs, personal incidence of stroke, heart disease, cancer, or/and hospital stays during the last 12 months. Similarly, a number between 0 and 2 was assigned for mobility difficulties (adding a fear of falling, dependency on mobility devices) and activity limitations (dependency on help for bathing, dependency on help for cleaning). A higher number was interpreted as showing a more severe medical condition, mobility difficulties, or activity limitations.

Secondly, to generate the measures of leisure engagement, the raw data of leisure performance and the raw data of leisure motivation were combined and subjected to the Rasch rating scale analysis by using the WINSTEPS program [35]. This procedure has been used and found to be a valid measurement for groups of older people [36]. The generated data was treated as valid if it met the common criteria for surveys of MnSq ≤ 1.5 and $z \leq 2.0$ [37]. To be included in the study, a valid response regarding leisure engagement was required. In total, data from 1 403 respondents was excluded due to invalid responses. A major reason for this error was that many participants had not answered the question about leisure motivation ("do you want to perform this activity?").

Lastly, we exported the leisure engagement scale measures to IBM SPSS Statistics, version 20, for continued analysis. The relationship between the engagement in leisure activities of older adults, different health indicators and sociodemographic control variables was assessed by using ordinary least squares (OLS) multivariate regression. We used the above-mentioned measure for leisure engagement as our dependent variable as well as three indexes measuring medical condition, mobility difficulties, and activity limitations as independent variables. We also controlled for sociodemographic aspects. Three regression models were calculated. The first model calculated a bivariate regression coefficient for each separate health indicator index on leisure engagement. The second model consisted of multivariate regressions of the above-mentioned health indicator indexes on leisure engagement. The third model was a full model assessing the association between leisure engagement and health indicators while controlling for sociodemographic characteristics.

3. Results

In this study a total of 5435 participants met the inclusion criteria, 1375 from Österbotten (25.3%), 845 from Pohjanmaa (15.5%), and 3215 from Västerbotten (59.2%). The most dominant type of person found in the sample was a 65-year-old (40.2%) women (55.5%) living in Västerbotten, Sweden (59.2%), together with someone (74%) and earning more than 1000€ a month (72.8%). Details about the sample are described in Table 1. The basic characteristics were similarly distributed in Finland and Sweden. Of the total sample 59.2% were Swedes (from Västerbotten, Sweden), 25.3% were Swedish-speaking Finns (from Österbotten, Finland) and 15.5% were Finnish-speaking Finns (from Pohjanmaa, Finland). Leisure engagement varied in the sample between the most engaged (5.10) and the least engaged (−4.60) with a mean 0.28 (SD 0.99).

Table 2: Frequencies (%) of medical conditions, mobility difficulties, and activity limitations in the studied group.

	Total sample $n = 5435$	Finland $n = 2220$	Sweden $n = 3215$
Medical conditions			
≥5 pharmaceutical drugs	1074 (20.4)	370 (17.2)	704 (22.5)
Stroke	352 (6.9%)	100 (4.8)	252 (8.2)
Heart disease	435 (8.7)	147 (7.2)	288 (9.7)
Cancer	749 (14.6)	299 (14.4)	450 (14.7)
Hospital care during the last 12 months	1018 (19.3)	409 (19.0)	609 (19.5)
Mobility difficulties			
Mobility device	645 (12.2)	228 (10.5)	417 (13.3)
Fear of falling	1389 (26.4)	454 (21.1)	935 (30.1)
Activity limitations			
Need help with bathing	326 (6.1)	107 (4.9)	219 (6.9)
Need help with cleaning	774 (14.4)	323 (14.8)	451 (14.2)

Table 3: The effects of medical conditions, mobility difficulties, and activity limitations on the leisure engagement of older adults. Results from bivariate and multivariate OLS analyses.

Independent variables	Model 1	Model 2	Model 3
Health-related risk factors			
Medical conditions (index)	-0.134^{***}	-0.052^{***}	-0.036^{*}
Mobility difficulties (index)	-0.273^{***}	-0.115^{***}	-0.079^{***}
Activity limitations (index)	-0.504^{***}	-0.196^{***}	-0.168^{***}
Sociodemographic variables			
Age (cont.)			-0.104^{***}
Language: Swedish (ref. Finnish and others)			0.068^{***}
Gender: female (ref. male)			0.056^{***}
Civil status: partnership (ref. single)			0.052^{***}
Income: high (ref. low)			0.062^{***}
Education: high (ref. low education)			0.083^{***}
Country: Sweden (ref. Finland)			-0.015
n		5435	5435
Adjusted R square		0.071	0.101

Note: the first model shows nonstandardised Beta coefficients from bivariate regressions of each health indicator of leisure engagement, whereas models 2 and 3 show standardised Beta coefficients from multivariate regressions. The variables, medical conditions, mobility difficulties, and activity limitations, are indexes. Age is a continuous variable and the other variables are "dummy" variables. $^{*}P < 0.95$ and $^{***}P < 0.999$.

Every fifth participant (about 20%) used 5 or more pharmaceutical drugs and reported a hospital stay during the last 12 months. The most frequently reported medical diagnosis was (some form of) cancer (15%). One quarter of the participants (about 25%) reported a fear of falling and about 14% needed help with cleaning. More details about medical diagnoses, mobility difficulties, and activity limitations are described in Table 2.

The first two models of the OLS regression (see Table 3) indicate that medical conditions, mobility difficulties, and activity limitations all have hampering effects on the leisure engagement of older adults, both when we consider the bivariate associations between each of the three indicators and leisure engagement (model 1) and when their relative importance for leisure engagement (model 2) is taken into consideration. As is shown in the table, the indicator having the biggest impact on the leisure engagement of older adults is activity limitations, while the two other health status indexes play somewhat lesser roles. Interestingly, the strong negative association between activity limitations and leisure engagement remains significant (which is also the case with mobility difficulties) even after we control for individual, sociodemographic characteristics, and country (model 3). This suggests an independent association between activity limitations, mobility difficulties, and leisure engagement. The table also shows that leisure engagement tends to decline with old age and that leisure engagement is higher among Swedish-speaking older adults than among Finnish-speakers and persons with other mother tongues. It is intriguing to note that one's mother tongue seems to play an important role in this respect, although the country variable does not seem to matter a great deal. As it is revealed in the figure, the Swedish-speakers in Finland also show a high rate of leisure engagement, which may explain why the country variable remains insignificant (see Figure 1). Furthermore, Table 3 shows that leisure engagement is higher among women, persons living together with someone else, persons with high incomes (pensions), and persons with higher levels of education.

4. Discussion

In this paper, we have analyzed the relationship between leisure engagement and medical conditions, mobility difficulties, and activity limitations. This study demonstrates that having a fear of falling, using mobility devices, and needing help with bathing and/or cleaning all have a significant impact on the level of leisure engagement in the case of older people. This impact remains significant even after controlling for variables such as gender, age, civil status, income, education, and language group affiliation.

For the purpose of this study, we operationalized mobility difficulties and activity limitations as an index that assessed whether older persons were experiencing a fear of falling and using mobility devices or if they were in need of help in order to bathe or clean themselves, respectively. Even though this is only one way of operationalizing mobility difficulties and activity limitations, it still gives an insight into how mobility issues as well as ability factors influence the extent to which older persons engage in leisure activities. Mobility issues and particularly a fear of falling have previously been studied and found to influence physical leisure activities negatively [38, 39].

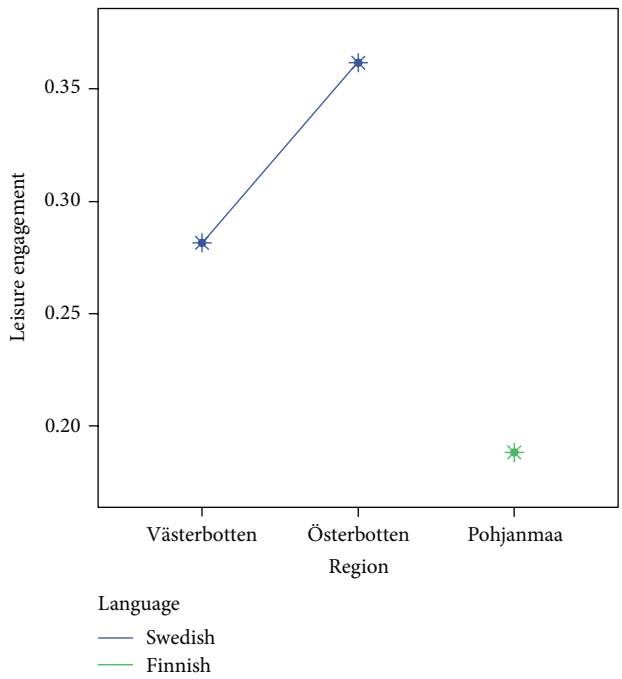

Figure 1: Illustration of how leisure engagement varies between Swedish- and Finnish-speakers in the study.

Medical conditions also play a role in predicting the level of leisure engagement. Yet this variable does not seem to play a role as big as that of mobility difficulties and activity limitations. Moreover, the variable of medical conditions loses its strength after controlling for sociodemographic variables. These results are somewhat supported by earlier findings [6, 40], which report that older people may view themselves as healthy despite suffering from chronic illnesses and disabilities. However, the negative link between illnesses or diagnoses and activities is often taken for granted or regarded as obvious (e.g., [41–43]) even though other researchers found that engagement in activities is affected by more than just diseases. Life style factors as well as persons' physical and social environment, for example, have been noted to play a role in the level of engagement in such activities [44–47].

With a regression model explaining about 10% of the variance in leisure engagement, this study demonstrates the need to examine leisure engagement no matter medical conditions, mobility difficulties, or activity limitations. Moreover, this study supports the need to consider age, gender, civil status, and socioeconomic status in terms of income and educational level when examining leisure engagement in the case of older people. In this study, leisure engagement varied between Finnish- and Swedish-speakers, but the country variable as such showed no impact on their engagement in leisure activities. This is an interesting finding that seems to separate the effects of language group affiliation from those of the geographic region where a person is resident (e.g., [32]). The results found in this paper also corroborate the findings from a recent study, which found that good self-rated health was high among Swedish-speakers in Sweden and Finland, respectively, but lower among Finnish-speakers in Finland [48]. Further, being in line with previous research [49], it seems like historical, social, and cultural differences attributed to belonging to a specific language group in Finland are playing an important role in explaining language group differences in leisure engagement. It has been suggested that the Swedish-speaking community in Finland live in tighter social networks as compared to the Finnish-speaking community [49] which might explain the high levels of leisure engagement among the Swedish-speakers in Finland in our study.

To what extent does leisure engagement of older persons depend on their level of activity limitations, their level of mobility difficulties, or their medical diagnoses, and to what may such engagement be related to other factors not examined in the present study? These factors need to be identified and highlighted in future studies. Environmental issues and physical and social factors may also be important here, as suggested in many theories [50–52]. Supports and barriers in the social, physical, or societal environment could, for example, be a part of interventions [53] but are also shown to influence physical activities and suggested to be used as predicting factors [54]. There might also be other, yet unknown, factors of importance to identify and incorporate into future evaluations of leisure engagement.

Earlier research supports a relationship between self-rated health, seen as an overall measure of health, and leisure engagement [55, 56] and this needs to be investigated further. Perhaps self-rated health could go together with medical conditions, mobility difficulties, and activity limitations to create a broader understanding of factors influencing the engagement in leisure activities.

Based on the results, we can question whether medical conditions have a great impact on leisure engagement. Other findings similarly reveal limitations in using medical conditions to predict a decline in the activities of daily living [57]. Hence, it is important to remember that only a few diagnoses and signs of medical conditions were included in this study's medical condition variable. If other diagnoses or signs, such as symptoms of depression and cognitive limitations, were included, the predictive strength of the regression models might be improved in terms of leisure engagement. Another limitation of this study is that self-reports of diseases are prone to be influenced by individual bias, particularly in the case of illnesses perceived as nonthreatening and that do not hamper a person's ability to live normally [58]. These illnesses may nevertheless increase the risks for a decline of a person's ability to function normally and need therefore to be considered. Although we used a population-based cohort, the exclusion from the analyses of participants with invalid responses on leisure engagement measures may have introduced bias and reduced the generalizability of the results. However, as the study is not limited to include only the performance of leisure activities, but also the motivational aspect of these activities, our measure on leisure engagement can arguably be seen as robust.

This study is based on self-reports, that is, on the accounts of older people assessing their engagement in leisure activities

as well as their experienced medical diagnoses, mobility difficulties, and activity limitations. Together, this contributes to an understanding about leisure engagement in later life. There is however a great need to study also other variables in the complex field of leisure engagement.

Disclaimer

The authors alone are responsible for the content and writing of the paper.

Conflict of Interests

The authors report no conflict of interests.

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Research Article

Functional Fitness and Self-Reported Quality of Life of Older Women Diagnosed with Knee Osteoarthrosis: A Cross-Sectional Case Control Study

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Aim. Utilizing a cross-sectional case control design, the aim of this study was to evaluate the functional fitness and self-reported quality of life differences in older people diagnosed with knee osteoarthrosis (O) who participated in health promotion groups. *Methods.* Ninety older women were distributed into two groups: control without O of the knee (C, $n = 40$) and a group diagnosed with primary and secondary knee O with grade II or higher, with definite osteophytes (OA, $n = 50$). Functional fitness was evaluated by specific tests, and the time spent in physical activity and quality of life was evaluated by the IPAQ and WHOQOL (distributed in four domains: physical: P, psychological: PS, social: S, and environmental: E) domain questionnaires. *Results.* No differences were found between ages of groups (C: 66 ± 7; OA: 67 ± 9; years). The values of the chair stand test (rep) in the OA (13 ± 5) group were different when compared to C group (22 ± 5). For the 6-minute walk test (meters), the values obtained for the C (635 ± 142) were higher ($P < 0.01$) than the OA (297 ± 143) group. The time spent in physical activity (min) was greater ($P < 0.001$) in the control (220 ± 12) group compared to OA (100 ± 10) group. Higher values ($P < 0.001$) in all domains were found in the C (P: 69 ± 16, PS: 72 ± 17, S: 67 ± 15, E: 70 ± 15) group compared to OA (P: 48 ± 7, PS: 43 ± 8, S: 53 ± 13, E: 47 ± 14) group. *Conclusion.* Our data suggests that knee O, in older women, can promote a decline in time spent performing physical activity and functional fitness with decline in quality of life with an increase in sitting time.

1. Introduction

Osteoarthritis (OA) is a chronic, multifactorial disease that leads to progressive functional disability [1] and has been considered one of the most frequent causes of incapacity for work in Brazil [1, 2] and worldwide [3]. Among the joints, knee, hip, hand, foot, and spine [3] are the most common areas for the development of osteoarthritis; however, the knee joint has been the most studied [4].

In histological studies, OA is characterized by focal areas of loss of cartilage in synovial joints by joining capsule thickening and bone hypertrophy with consequent formation of osteophytes and bone sclerosis [3, 5]. Joint pain, tenderness, limitation of movement, crepitus, occasional effusion, and variable degrees of local inflammation are usual signs in the clinical condition of impairment [3, 4]. Around the risk factors, age, female gender, previous joint injury, genetics, and muscle weakness [5] are important factors to pathogenesis;

however, many individuals are affected by lifestyle factors such as obesity and lack of physical activity [3, 5].

In the USA it is estimated that 25% of people aged over 65 years suffer from pain and other disabilities associated with OA [6]. In Brazil, there are no precise data on prevalence; however, Coimbra et al. [1] report that it is the most common rheumatic disease found in women in Brazil among individuals over 65 years [6]. As a result, OA will be an important public health problem in future years in Brazil due to the increase in age of the population [7].

The conservative treatment of knee OA requires analgesic therapy for long periods [8]; however, the pharmacological treatment should always be multifactorial [1]. Physical exercise had been used in conjunction with pharmacological treatments. No pharmacologic strategy alone has been identified as an effective method of therapeutic intervention demonstrating pain relief and increased mobility related to patients with knee OA [1, 4, 5, 9, 10]. Additionally, local physical therapy, rehabilitation, and reduction of mechanical stress on joints may provide improvements in pain symptoms and maintain joint function, which mainly reflects the improvement in the quality of life of people affected by the disease [4].

In older patients, functional fitness is impaired by pain, joint stiffness, and muscle atrophy and bone crepitus [4, 5]. In this context, functional fitness evaluation had been highlighted as a relevant strategy utilized for older people [11] and is an indicative measure that individuals have to decide about their functional capacity and that relates to their day to day living and capacity to perform [6, 12, 13]. Another important disclosure has been to address the quality of life [14]. Additionally, studies [6, 13] have shown significant reductions in self-reported quality of life, including pain increase and physical and psychological stress [13]. Considering these points and to address some of the gaps observed in both the literature and experimental studies, the aim of this study was to evaluate the functional fitness and self-reported quality of life differences in older people. Two groups were evaluated, subjects diagnosed with knee osteoarthrosis and a control group without osteoarthrosis of the knee.

2. Material and Methods

After approval by the Research Ethics Committee of Nove de Julho University (466/2012), ninety older women (over 60 years) participants of health promotion groups (method of collective and interdisciplinary health intervention, consisting of a group process) were recruited from the Regional Community Adult Day Care facilities by Nove de Julho University and distributed into two groups: without osteoarthrosis of knee (control, *n*: 40) and with primary and secondary knee osteoarthrosis (OA, *n*: 50). All participants had medical examinations and completed questionnaires regarding medical history. All protocols used in the study were performed in accordance with the ethical standards of the Helsinki Declaration.

The following exclusion criteria were assigned: chronic knee pain, knee surgery, current or previous participation in regular exercise programs in the past six months, recent hospitalization, cardiorespiratory disease, severe hypertension, metabolic syndrome and liver or kidney disease, cognitive impairment or progressive conditions with debilitating inability to exercise, recent bone fractures, any knee surgery earlier, and any other medical contraindications for training.

Table 1: The radiographic parameters for knee OA diagnosis.

Grade	Criteria
0	Normal
1	Doubtful joint space narrowing, possibly developing osteophytes
2	Definite osteophytes, narrowing missing or questionable joint space
3	Osteophytes moderate, definite narrowing some sclerosis possible joint deformity
4	Large osteophytes marked narrowing sclerosis severe joint deformity established

The OA diagnosis was based on clinical and radiographic parameters, in line with the American College of Rheumatology [15] and individual medical history. The radiographic parameters for knee OA diagnosis were established according to the classification of Kellgren and Lawrence [16], with involvement of the knee on or above grade II, conform described on Table 1.

2.1. Physical Activity Level. Utilizing the interview strategy, the short form International Physical Activity Questionnaire (IPAQ) was used to estimate physical activity levels. The questions were asked of all subjects on the week preceding the physical activity measures. The questions asked explored the frequency and duration of physical activity including walking, moderate and vigorous physical exercise, and sitting time. Individuals were considered active if they participated in physical activity for more than 150 minutes per week and inactive if their participation levels were less than 150 minutes per week.

2.2. Anthropometric Parameters. The anthropometric measures used in this study were similar to those previously reported by our group [14, 17]. Stature was measured to the nearest 0.1 cm using a Cardiomed WCS stadiometer (Curitiba, Brazil). Body mass was measured to the nearest 0.1 kg using a Filizola Personal Line 150 scale (São Paulo, Brazil). Body mass index (BMI) was calculated as follows: $\text{BMI} = \text{weight}/\text{height}^2$.

2.3. Functional Fitness. Functional fitness evaluation comprised six tests previously reported in the literature to assess physical performance parameters concerning mobility and balance in older adults [12, 14, 17, 18]. The following tests were utilized.

2.3.1. Arm Curl Test. It was used to evaluate upper limb fitness, with the analyzed score as the total number of hand weight curls through the full range of motion.

Table 2: Anthropometric parameters.

Parameters	Control	OA	95% of IC	Significance
Age (years)	66 ± 7	67 ± 9	−1.932–4.922	$P > 0.05$
Body mass (kg)	66 ± 7	67 ± 9	−0.631–7.672	$P > 0.05$
Height (cm)	167 ± 0.12	164 ± 0.13	−0.090–0.011	$P > 0.05$
BMI (kg/m^2)	30 ± 5	33 ± 5	0.690–4.920	$P < 0.01$

Values expressed in mean ± SEM of control and osteoarthrosis (OA) groups. BMI: body mass index.

2.3.2. Chair Stand Test. It was used to evaluate lower limb strength, scored by the number of full stand-ups executed correctly within 30 seconds.

2.3.3. Agility. It was evaluated by the 8-foot up-and-go test (TUG), and the score recorded was considered the shortest time to rise from a seated position, walk eight feet, turn back, and return to the seated position.

2.3.4. Sit and Reach Test. It was used to evaluate the lower body flexibility scored by the shortest distance achieved between the extended fingers and the toe when seated with extended leg and heel resting on the floor.

2.3.5. Static Balance. It was assessed by having subjects stand on one leg for a maximum of 30 seconds on each side. The score was measured, allowing only minimal fluctuations of ankle position or obvious toe clawing, without hopping or upper limb movement. The test was stopped after 30 seconds if hopping occurred, the ankle movement was excessive, or the hanged foot touched the floor or contacted the stance leg/foot.

2.3.6. Functional Exercise Capacity. It was measured by 6-minute walk test [6].

2.4. Quality of Life. Quality of life was evaluated by a shortened WHO quality of life questionnaire as outlined previously [14, 17, 19]. The questionnaire comprised 25 questions about several aspects of quality of life, including the following.

2.4.1. Physical Domain. It concerns pain or discomfort, energy or fatigue, sleep, rest, mobility, daily activities, medicine dependency, and job performance.

2.4.2. Psychological Domain. It includes feelings, learning, memory and attention, self-esteem, aspect, spirituality, religiousness, and positive or negative thinking.

2.4.3. Social Domain. It deals with personal relationships, social support, and sexuality.

2.4.4. Environmental Domain. It includes physical security, home environment, financial security, opportunity for information assessment, social or cultural event participation, and activities undertaken during spare time. Each domain was scored from 0 to 100 points, and higher scores represented improvement.

2.5. Statistical Analyses. All statistical analyses were performed using SPSS software (v 12.0; IBM, Armonk, NY, USA). The D'Agostino-Pearson test was applied to Gaussian distribution analysis. Analysis of comparisons between groups over time was performed by Student's t-test or Mann-Whitney test. Statistical significance was established at $P < 0.05$. Data are expressed as mean ± SEM.

3. Results

During functional fitness evaluation phase program, 10 women of OA group dropped out of study due to knee pain during execution of the test. Therefore, fifty women were included on OG group.

The anthropometric parameters are presented in Table 2. The body mass and stature did not differ between groups. However, the BMI of OA group was higher than control group.

Significant differences ($P < 0.01$) were found between time spent in physical activity (control: 220 ± 12 versus OA: 100 ± 10; minutes) and sitting time (control: 1673 ± 532 versus OA: 2675 ± 680; minutes) between groups.

Functional fitness scores are outlined in Figure 1. Statistical differences ($P < 0.01$) were found between groups between the chair stand test (control: 22 ± 5 versus OA: 13 ± 5 rep.), arm curl test (control: 22 ± 6 versus OA: 18 ± 4), sit and reach test (control: 23 ± 4 versus OA: 12 ± 5; cm), TUG (control: 18 ± 6 versus OA: 29 ± 4; sec), 6-minute walk test (control: 635 ± 142 versus OA: 297 ± 143, m), and balance (control: 18 ± 4 versus OA: 11 ± 3; sec).

In all quality of life domains the control (physical: 69 ± 16, psychological: 72 ± 17, environmental: 67 ± 15, and social: 70 ± 15) was higher ($P < 0.001$) than OA (physical: 48 ± 7, psychological: 43 ± 8, environmental: 53 ± 13, and social: 47 ± 14) as shown in Figure 2.

4. Discussion

The main objectives of this study were to identify differences in time spent in physical activity, functional fitness, and quality of life with increase in sitting time in older people diagnosed with knee OA. Previous studies [3, 6] suggested that obesity may be considered a risk factor for the development of OA. Falsarella et al. [6] demonstrated that individuals with a high BMI (above 25 kg/m^2) had an association with

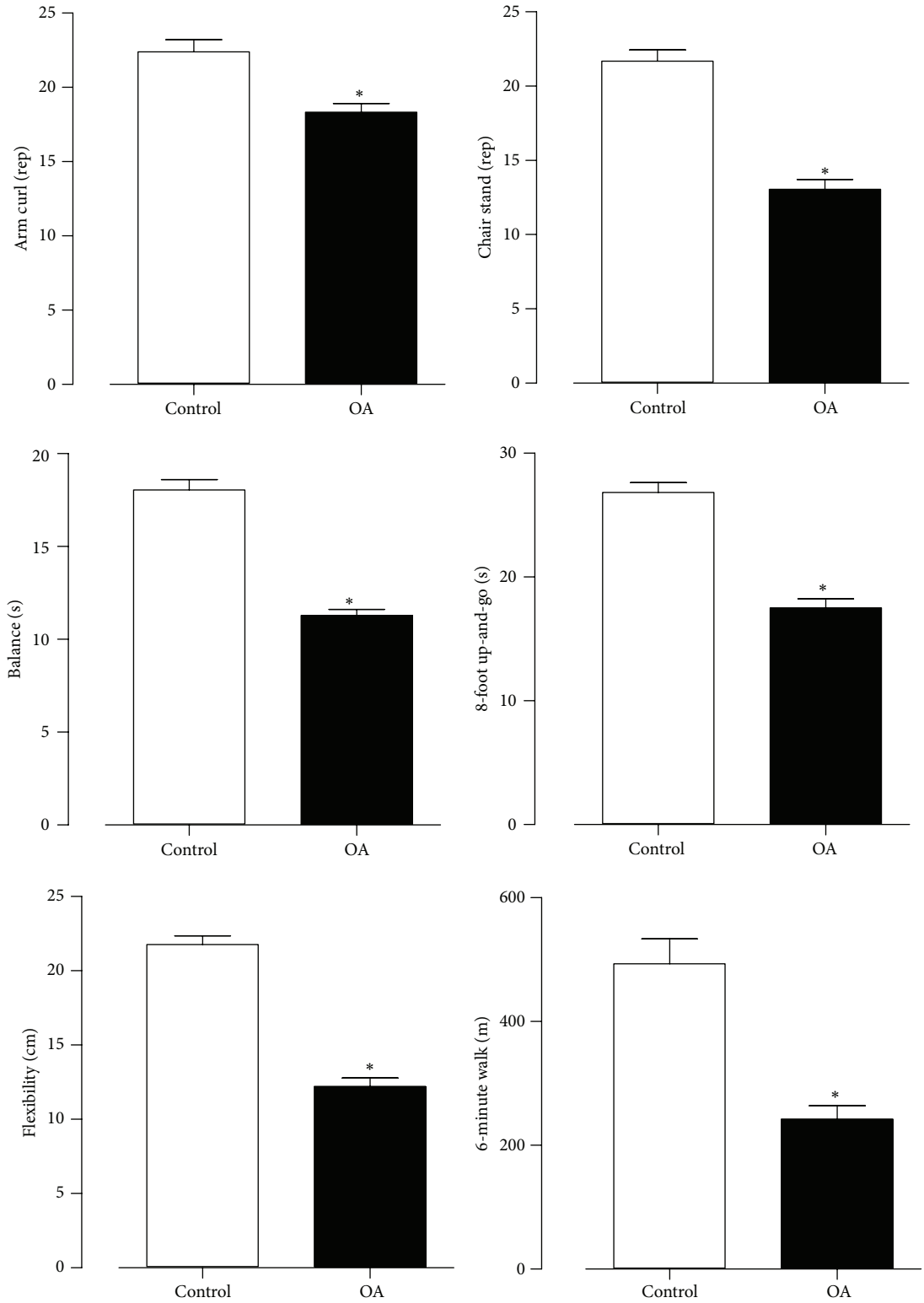

Figure 1: Values expressed in ± SEM of functional fitness test of control and osteoarthrosis (OA) groups. $^{*}P < 0.05$.

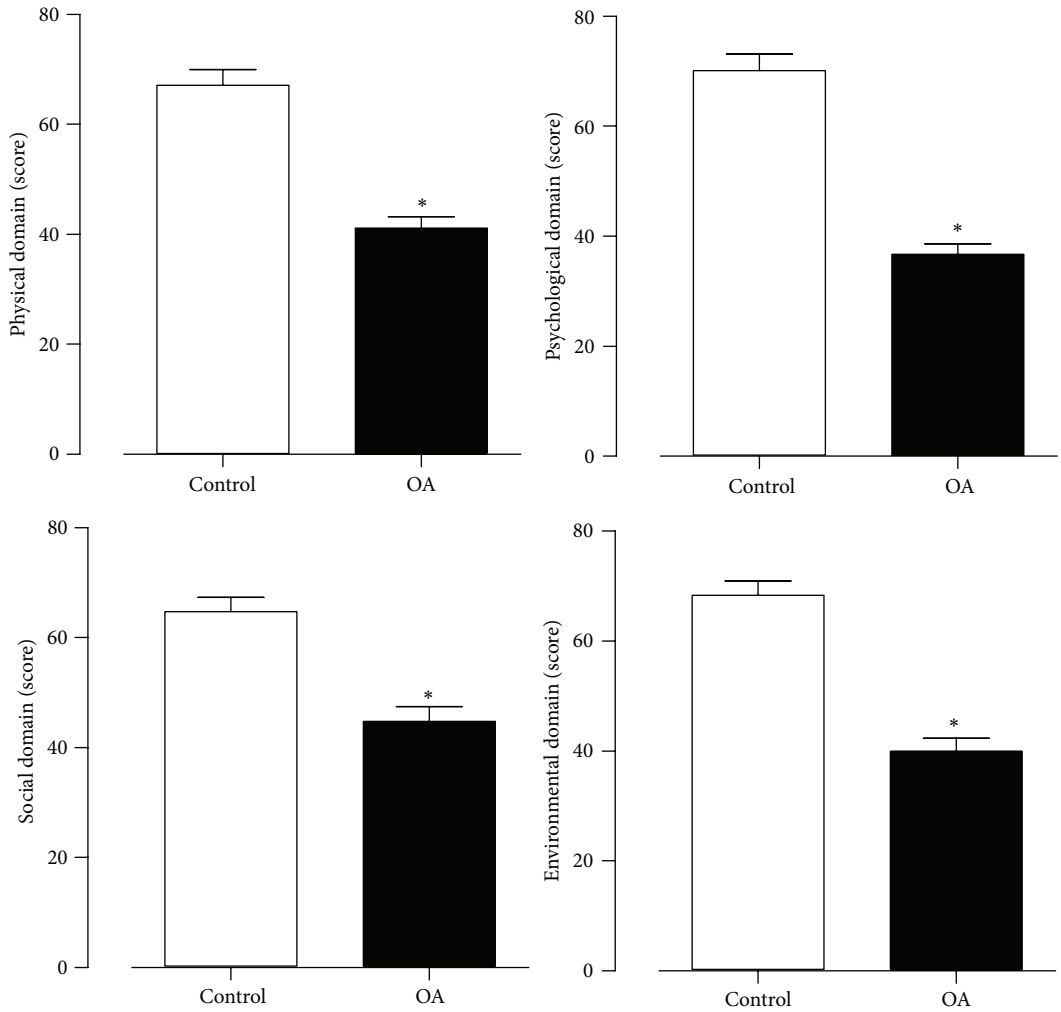

Figure 2: Values expressed in ± SEM of quality of life of control and osteoarthrosis (OA) groups. $^{*}P < 0.05$.

joint symptoms; however, Niu et al. [20] demonstrated that obesity is not related to the progression of knee OA.

The decrease in muscle strength is associated with reduced joint flexibility and impairment of functionality, limiting the realization of occupational activity and compromising the welfare on aging [21]. The strength deficits in OA people, evaluated by electrical stimulation of quadriceps muscle by maximal strength voluntary contraction, varied between 15% and 18% on early disease, 24% in level II, according to Kellgren and Lawrence [16], and 38% in level IV [22]. In our study, we found a deficit of muscular strength of 40% in the lower limb when compared to control group. Additionally, our lower limb values (22 ± 5 repetitions) correspond to the findings of previous studies [17, 23].

However, cause-effect relationships between muscle weakness and OA are complex and have been widely debated [10]. Although the muscular strength probably decreases in people with OA as a secondary result of reduced activity, there is evidence that muscle weakness directly contributes to development and progression of OA [24]. Therefore, it may be possible that muscular weakness of the quadriceps could be responsible for functional impairment, predisposing structural damage to the knee, since this muscle acts as a shock absorber in this joint [25].

Ueno et al. [26] reported that changes in older people's flexibility may compromise functional fitness, reducing some activities of daily living. In this study the greater decline in flexibility in OA group was observed. Additionally, Oliveira et al. [2] suggested that improvement in muscular stretching may reduce stiffness and joint pain and improve physical function in osteoarthritis subjects.

The TUG is the most favorable test developed to assess parameters of physical mobility, translated agility, speed, and dynamic balance [18]. Evidence [11] indicates that the knee receptors have an important role in the control of posture, balance, and locomotion capacity. The changes in these receptors may be responsible for the dysfunction on gait pattern in aging, which may be related to muscle reflexes protectors [27]. Although no neural measurements had been done, we considered that alterations may be associated with performance testing changes in OA group.

In relation to aerobic capacity, Jackson et al. [28] showed a reduction by 1% per year and about 50% of this decline is related to inactive lifestyle and a poor body composition. In OA patients, weight loss can lead to significant improvements in reduction of disability and knee burden [5]. Additionally, aerobic exercises can improve VO_2 peak in this population [5]; however, in the OA group, the time spent in physical activity was lower and sitting time was higher than WHO recommendations. This probably contributed to the poor aerobic fitness levels observed. Similar to our study, Tamegushi et al. [13] demonstrated significant impairment on 6MWT outcome in OA knee patients.

Studies [5, 6, 29] have demonstrated that functional fitness reductions affect significantly self-reported quality of life in the OA older patients. Falsarella et al. [6] indicated that a reduction in joint pain is the most important fact related to this statement; conversely, Alves and Bassitt [29] observed that OA patients have a good quality of life, regardless of functional fitness impairment.

This is a relatively small sample and case control study, with no information about long-term outcomes. Nevertheless, for future public health strategies, this work reinforces the message of the importance of the frequency and regularity of clinical investigation. In addition, there may be some small inaccuracies in estimating maximum aerobic fitness (indirect test). Nevertheless this drawback was common to both the control and OA groups and for all evaluations, thus reducing inaccuracy.

5. Conclusion

The present study suggests that knee osteoarthrosis in older women can promote a decline in time spent performing physical activity, functional fitness, and quality of life with consequent increase in sitting time. Thus, despite inherent limitations, our data reinforce the safety and utility of clinical approach strategies that should be considered to address issues observed in this population.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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Research Article

A Community-Based, Technology-Supported Health Service for Detecting and Preventing Frailty among Older Adults: A Participatory Design Development Process

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Frailty is a multifaceted condition that affects many older adults and marks decline on areas such as cognition, physical condition, and nutritional status. Frail individuals are at increased risk for the development of disability, dementia, and falls. There are hardly any health services that enable the identification of prefrail individuals and that focus on prevention of further functional decline. In this paper, we discuss the development of a community-based, technology-supported health service for detecting prefrailty and preventing frailty and further functional decline via participatory design with a wide range of stakeholders. The result is an innovative service model in which an online platform supports the integration of traditional services with novel, Information Communication Technology supported tools. This service is capable of supporting the different phases of screening and offers training services, by also integrating them with community-based services. The service model can be used as a basis for developing similar services within a wide range of healthcare systems. We present the service model, the general functioning of the technology platform, and the different ways in which screening for and prevention of frailty has been localized. Finally, we reflect on the added value of participatory design for creating such health services.

1. Introduction

Aging can be considered a success story for health policies in the modern world. And while living longer is a beautiful thing, it also comes with downsides, such as frailty. Frail older adults are those "who are at increased risk for future poor clinical outcomes, such as development of disability, dementia, falls, hospitalization, institutionalization, or increased mortality" [1]. As such, frailty is a state that consists of many dimensions. Physical and cognitive decline, as well as malnutrition, have been identified as the major dimensions of frailty among older adults [2]. Becoming frail is something that happens gradually. A person starts out robust (or healthy), becomes prefrail (a stage in which components of frailty become manifest), and can then evolve to become frail (which can be observed clinically easily) [3]. In ten European countries, the percentage of prefrail people among community-dwelling older adults have been found to range from 30.4% to 44.9%, and the percentage of frail people among this group ranged from 1.3% to 5.9% [4].

Determining the level of frailty among older adults and offering them interventions to train their health have been found to help them live at home independently for a longer amount of time and to reduce the rate of falls [5]

or helps them to maintain their functional capacity [6]. However, current identification methods for frailty and prefrailty among older adults are resource-intensive and more efficient (but equally reliable) alternatives need to be developed [7]. This need aligns with the great challenges that society has to deal with in organizing its healthcare. Demand is rising due to a population that includes increasingly more older adults that have to be supported by increasingly fewer young people; older adults should be able to function in society independently and without drawing too much on society's resources; increasingly high standards of living lead to higher expectations with regard to the quality of care while budgets are being tightened [8]. Two types of healthcare services have been identified as possible solutions to these problems: community-based services and eHealth [9, 10]. A community-based healthcare service is a form of care that is provided out of medical institutions within a patient's community. This does not mean that healthcare professionals (e.g., a general practitioner) are not involved. Rather, the majority of the service is provided at a location in a patient's neighborhood that is not care-related (e.g., the community house) and involves a collaboration of healthcare professionals, local organizations, and volunteers. For the context of care for older persons, such services are meant to help older people live independently in their own house while maintaining their quality of life [11]. Community-based services can be a method to decrease the pressure on the healthcare system by moving care from medical institutions towards local community services. Collaborations between primary care, volunteers, and community services have been shown, among other things, to be able to predict poor nutrition among older adults [12], to prevent hospitalizations and major disabilities among chronically ill older adults [13], and to prevent the number of falls among older adults with a history of falling or having concerns about falling [14].

eHealth (or "health services and information delivered or enhanced through the internet and related technologies" [15]) has been proposed as a solution for overcoming the aforementioned challenges and is associated with great promises, such as improved access to health information, greater quality of care, and higher adoption of healthy behavior [16]. By means of eHealth services, patients can be empowered to take care of themselves, assisted by technology. This way, the burden on the healthcare system decreases, while patients gain control.

A community-based, technology-supported service model for screening for frailty among older adults and training their health can be a cost-effective alternative for the clinically based services that are currently available. By combining both approaches, care is moved away from care institutions, while it allows older adults to choose which kind of service they prefer (face-to-face in the community or via online self-service technology). But creating such a service means that new working procedures need to be devised. Therefore, involvement from stakeholders and potential end-users is extremely important [17, 18]. In this paper, we discuss the development of a community-based, technology-supported service model that aims to detect and prevent frailty among older adults, by means of a participatory design approach.

2. Materials and Methods

2.1. Participatory Design. We approached the design of the service model by means of participatory design. Participatory design is a design approach that advocates the inclusion of all stakeholders (including potential end-users and/or their representatives) during design activities in order to come to a design solution that aligns with all stakeholders' and end-users' needs and context [19, 20]. We conducted a series of workshops in which stakeholders and end-user (representatives) were gathered with multiple goals. First, we wanted to create awareness of the upcoming services. Second, we gathered direct input from the people that we anticipated to be actually working with the service or were going to be affected by it for service design. And third, as the workshop participants, for a large part, were also going to be the persons working with in the service, providing them input would them a sense of responsibility and ownership that, in turn, leads to higher acceptance [21].

2.2. Project Context. The design of the service model was part of the European FP7 project PERSSILAA (which stands for Personalised Information Communication Technology (ICT) Supported Services for Independent Living and Active Ageing). This project has the goal to develop a health service for detecting and preventing frailty among older adults by offering them innovative eHealth services and has a strong basis in their local community. Within this project, we see frailty as the rate of functional decline, whereby people can be robust (no functional decline), prefrail (some to quite some functional decline), and frail (an amount of functional decline that necessitates immediate medical intervention). eHealth interventions for improving physical and cognitive functioning and a website for educating older adults about healthy nutrition were developed in the project for improving older adults' health. The nutritional intervention educates people about healthier choices and to improve food habits, geared towards older adults. The physical intervention focuses on exercising for strength, endurance, and mobility training. The cognitive intervention, finally, targets improving the main cognitive functions: attention, memory, and executive functions. Those older adults that, during a screening, displayed some decline on the nutritional, cognitive, or physical aspect can then make use of these interventions. The service was initially developed for and implemented in two regions: Campania in Italy and Enschede in Netherlands. At the start of the project, an initial, high-level service model was developed by the project partners (including clinicians and experts in telemedicine) that served as input during the initial workshops (which are described below). In this model, the use of technology was foreseen during screening and prevention, but it still remained unclear how older adults could be guided best to the services, what the role of healthcare professionals was, how older adults should be guided during training, and so forth.

2.3. Setup in Italy. A first meeting was organized to create awareness among relevant stakeholders about the upcoming service for detecting and preventing functional decline and for the activities which would be deployed within its scope. The meeting (and the workshops that followed) also provided the opportunity to identify existing gaps in terms of digital and health literacy so that support could be arranged for overcoming these gaps and to facilitate the adoption of the innovative, ICT-supported services. A set of organizations that were closest to the older adults in the community (i.e., they are key stakeholders) were invited. These key stakeholders were then expected to discuss the proposed service with others in their vicinity. The stakeholders were selected and contacted based on the knowledge and experience of Caritas. Caritas is an international, religious organization that aims to improve the life and possibilities of people, by working closely with local churches. As in the Campania region (where the service model would at first be deployed), religion and spirituality play a large role in the life of older adults, Caritas and the Catholic Church were taken as the starting point for service design. In the end, 60 people attended the meeting. They were representatives from local hospitals, local nonprofit organizations that were interested in collaborating (such as Caritas or a large, local Judo club), local governments, seniors' associations, and the older adults themselves. During this meeting, the following topics were presented and discussed with all representatives and older adults to elicit the background knowledge needed to set-up local activities for detecting and preventing frailty:

(1) the role of older adults within the service and the service design (emphasizing the concept that the older adults are at the same time "object" of the screening, and "partners" in that their feedback was important for optimizing the service design and implementation);

(2) the initial service model;

(3) a comparison with other, highly-esteemed, sociosanitary services in Italy;

(4) making use of voluntary work to support the detection and prevention of functional decline (focusing on health promotion, socialization, and health and ICT literacy);

(5) the use of ICT to offer new services and the integration of the new services with existing medical information systems;

(6) how to provide older adults with an environment that makes it easier to make a life-altering change towards a healthier lifestyle.

This meeting led to an ideal service model that was subsequently detailed during nine meetings with representatives from two local communities where the service would be made available and the other key-stakeholders, like Caritas, general practitioners, the municipal health service, involved nonprofit organizations, and the local hospital. The goal of these workshops was to transform the ideal service model into a model that could easily be implemented locally by modifying it to fit local contexts in terms of opportunities (available resources), needs, and expectations. An ideal model was used as input for these meetings, as such models can aid a discussion on how to set up a service in a local community [22]. The meetings were held over a period of three months. While the first meeting was plenary (and included an overview of the aims of the service and the ideal service model), in-between meetings were focused more on specific topics (such as developing sessions in which the detection of frailty is combined with health literacy classes for older adults). Over time, the following topics about the anticipated service model were discussed with and among all stakeholders:

(1) the current role(s) and task(s) of every stakeholder with regard to detecting, monitoring, and preventing functional decline;

(2) the gain of every stakeholder to participate in and use the service;

(3) the envisioned role(s) and task(s) of every stakeholder within the service;

(4) agreement on the division of role(s) and task(s) among the stakeholders.

2.4. Setup in the Netherlands. A first workshop had the goal to create an "ideal" service model. This was done with a wide range of stakeholders and end-user representatives: a community nurse, a specialist in geriatric medicine, a general practitioner, a manager of a homecare organization, a representative from a municipality, a representative from a seniors' association (who acted as end-user representative), and a representative of a municipal health service. These stakeholders were selected after a brainstorm in which as many relevant stakeholders as possible were listed. Subsequently, they were ranked on three attributes that make up stakeholder salience: power, legitimacy, and urgency [23]. This ranking was used to determine which stakeholders were most needed at the workshop. After an introduction, the following subjects were discussed:

(1) each participant's current roles and tasks regarding detecting and preventing frailty and functional decline;

(2) an inventory of problems with the current way frailty is dealt with in care;

(3) introduction of a conceptual service model (e.g., demonstrating the options technology provides for training health on a distance);

(4) listing the roles and tasks each participant sees for himself/herself in the new service model;

(5) mapping the perfect procedure for a fictitious persona.

This workshop led to an "ideal" service model that was subsequently refined in a set of nine meetings and workshops with representatives from local organizations that resided in the area in which the service would be deployed for

the first time. Like we mentioned above, this tactic was used to aid the discussion on how to set up a service in a local community. These nine meetings were held with the municipality, a healthcare center, a healthcare insurer, a physical therapy practice, a healthcare organization for older adults, a community center, the University of Applied Sciences, and the researchers. The goal of these workshops was to transform the ideal service model into one that would fit the stakeholders' and users' contexts and routines. These meetings were also held in a time span of three months. Not all meetings were held with all stakeholders. Where the first and last meeting were plenary, in-between meetings were held to discuss issues affecting mainly a few stakeholders (such as creating a student assignment that allows students of the Applied University to do an internship within the project). The topics that were addressed during these meetings were similar to those in Italy: determining current roles of the stakeholders, assessing their potential gain, determining the role(s) and task(s) each stakeholder would like to have, and reaching consensus over the division of roles and tasks.

2.5. Data Analysis. Both plenary meetings in Italy and Netherlands (where the "ideal" service models were created) were audio-recorded and transcribed. Next, they were analyzed by means of thematic analysis whereby stakeholders' and end-users' interests with respect to frailty care, and their preferred role(s) and task(s) within the process of detecting and preventing frailty were mapped. The ideal service model was mapped by means of an activity diagram. In Italy, the subsequent meetings to refine the service model were documented via minutes of the meetings that were confirmed by all parties present. In Netherlands, after each meeting an improved version of the service model was created that was discussed in a subsequent meeting until all stakeholders agreed that this was a suitable service model. The final service models were also mapped by means of activity diagrams.

3. Results

3.1. The "Ideal" Service Model. The initial meetings that were used to come to an "ideal" service model resulted in two important insights about the way frailty care is currently provided; detection and prevention of frailty is dispersed over many different actors who do not collaborate, and there is currently no shared language for dealing with frailty. These views were shared in both countries. Next, for the to-be-developed service all stakeholders and end-users agreed on the following starting points.

(1) The older adult is responsible for the management of his or her own health and should be the party that takes initiative when health problems should be addressed (urgently).

(2) General practitioners want to be informed about the results of the screening, and there is a need to integrate their routine activities with the novel services for the detection and prevention of frailty and functional decline. Hereby, the aim is not to provide any additional work for them.

Alongside, in Italy it became apparent that there is a need for activities that educate older adults about working with ICT technology (e.g., the internet). Ideally, activities with regard to frailty detection and prevention should be combined with meetings in which older adults learn to work with ICT.

The ideal service models that were discussed resulted in an initial design in which older adults are invited for a two-stage screening process (one consisting of questionnaires, one consisting of physical and cognitive tests and additional questions) that identifies their rate of functional decline and classifies them as either robust, prefrail, or frail. While frail individuals are referred to a medical professional, and robust people receive an invitation for a new screening a year later, the group of prefrail people (those with some functional decline) are offered eHealth interventions for improving their cognitive functioning and physical functioning or for educating them about healthy nutrition for older adults. These services can be accessed at home, or, for the Italian context: at the local church, where the older adults are helped by trained volunteers. During the process, the general practitioner is kept up to date about the results and is only involved when an older adult needs urgent attention. For the two contexts, the ideal service model was mapped by means of activity diagrams (see Figure 1 for an excerpt in which an older adult is invited for and undergoes a first screening). These activity diagrams then served as input for the subsequent meetings in which the service model was further refined.

3.2. Refining the Ideal Service Model. In a series of meetings with local stakeholders in Italy and Netherlands, the ideal service models were refined, so that they could be implemented in practice.

In Italy, the subsequent meetings were used to formalize the division of tasks and to make this official by specific agreements. Next, tasks were divided and new organizations were included as collaborators, like Health Campus, a non-profit organization that involves more than 200 volunteer clinicians and focuses on providing free health screenings and promotes healthy lifestyles. Finally, the need for solving the existing health and ICT literacy gaps was addressed. The solution was found in an interactive "nutrition meeting," where people learned about healthy nutrition, were provided essential information on preventive medicine, and were in parallel taught ICT skills (use of office functionalities, to write down recipes, prepare PowerPoint presentations, access, and navigation on the internet to search for nutritional information, etc.). This way, they could gain the knowledge necessary for making well-informed dietary choices, and could receive additional information from professionals on topics they identified as relevant. At the same time, they could also learn the ICT skills that are needed in today's society and for making use of the service's ICT modules. To support the ICT training, another non-profit organization, Progetto Alpha, collaborated. Support was also provided by general practitioners of "Salute in Collina," by the Campania Regional Center for Urban Veterinary Safety and by the Department of Public Health of Federico II University.

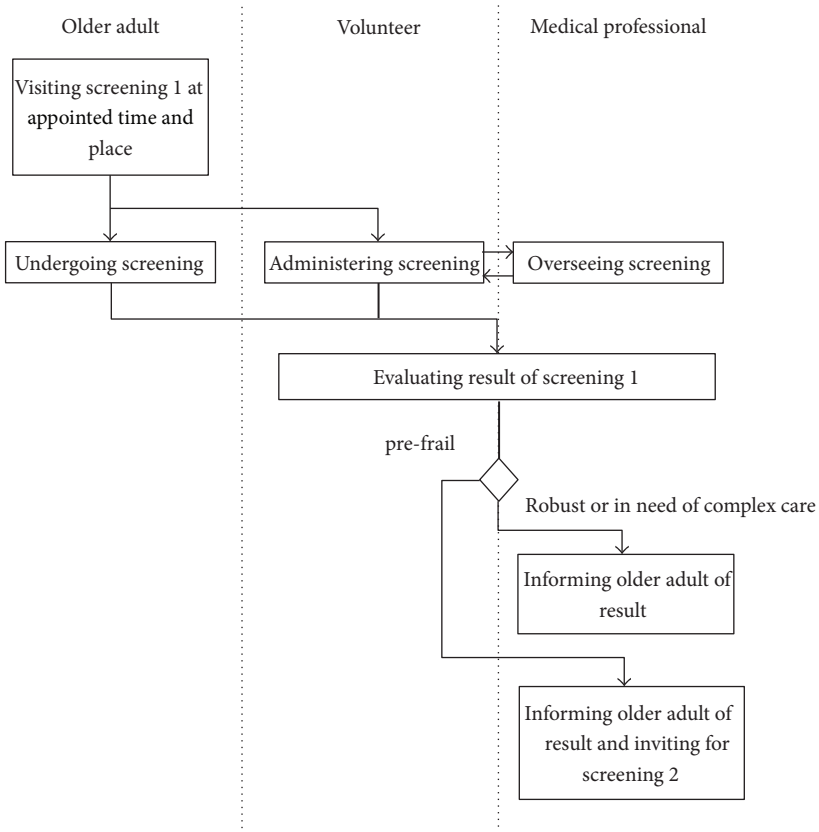

Figure 1: Excerpt of the "ideal" service model activity diagram for Italy.

In Netherlands, local general practitioners were doubtful about the feasibility of providing screening and training services via the internet only. They thought many older adults would not have access to the internet. Furthermore, they would like to see older adults leaving their house and mingling with other people, as loneliness is quite a big problem. Therefore, we explored new collaborations for opening up screening and training services in the local community. New partners were happy to be involved and it was agreed upon that kiosks will be opened at a local physical therapy practice, a healthcare organization for older adults, and the local community center. Next, the need for a cost-effective, sustainable business model led to the idea to involve the local University of Applied Sciences, which is always in a need for places for their students to do an internship. The University of Applied Sciences was also willing to collaborate and it was decided upon that their students (physical therapy and nursing) will support the logistics behind the service (e.g., sending out invitations) and will support the older adults during the screening and training, both at home and at a location within the community.

3.3. A Community-Based, Technology-Supported Service Model for Detecting and Preventing Frailty among Older Adults. Figure 2 displays the service model that was created on the basis of the ideal service models and the alterations that were made in the subsequent meetings. In the service model, there are unique routes for entering the screening and training services. In Italy, older adults are invited for the first screening via the church, after which they can complete this screening at the church with the help of a trained volunteer or online. As older adults in Italy frequently visit the church, where many activities take place, this appeared to be the best way to reach them. In Netherlands, older adults are invited by the general practitioner's office (in name only, logistics are handled by the students) after which they can complete the first screening at home on paper, online, or with the help of a trained student. The general practitioner was chosen as the party sending out the invitations as this would yield the highest response from the older adults, due to his or her authority. This first screening consists of a set of questionnaires to assess an individual's general health status and his or her physical and cognitive status, as well as their nutritional habits (by means of questionnaires like the Groningen Frailty Indicator and the Mini Nutritional Assessment). In all cases, the results of the first screening are sent or uploaded to a central database that also determines the outcome for every individual (using cut-off scores for the different survey instruments that classify an individual as frail, (pre)frail, or robust, based on their rate of functional decline). Frail individuals are referred to a medical specialist (e.g., the general practitioner), who will, after personal examination, make a diagnosis and determine a treatment plan. Robust individuals will receive an invitation for

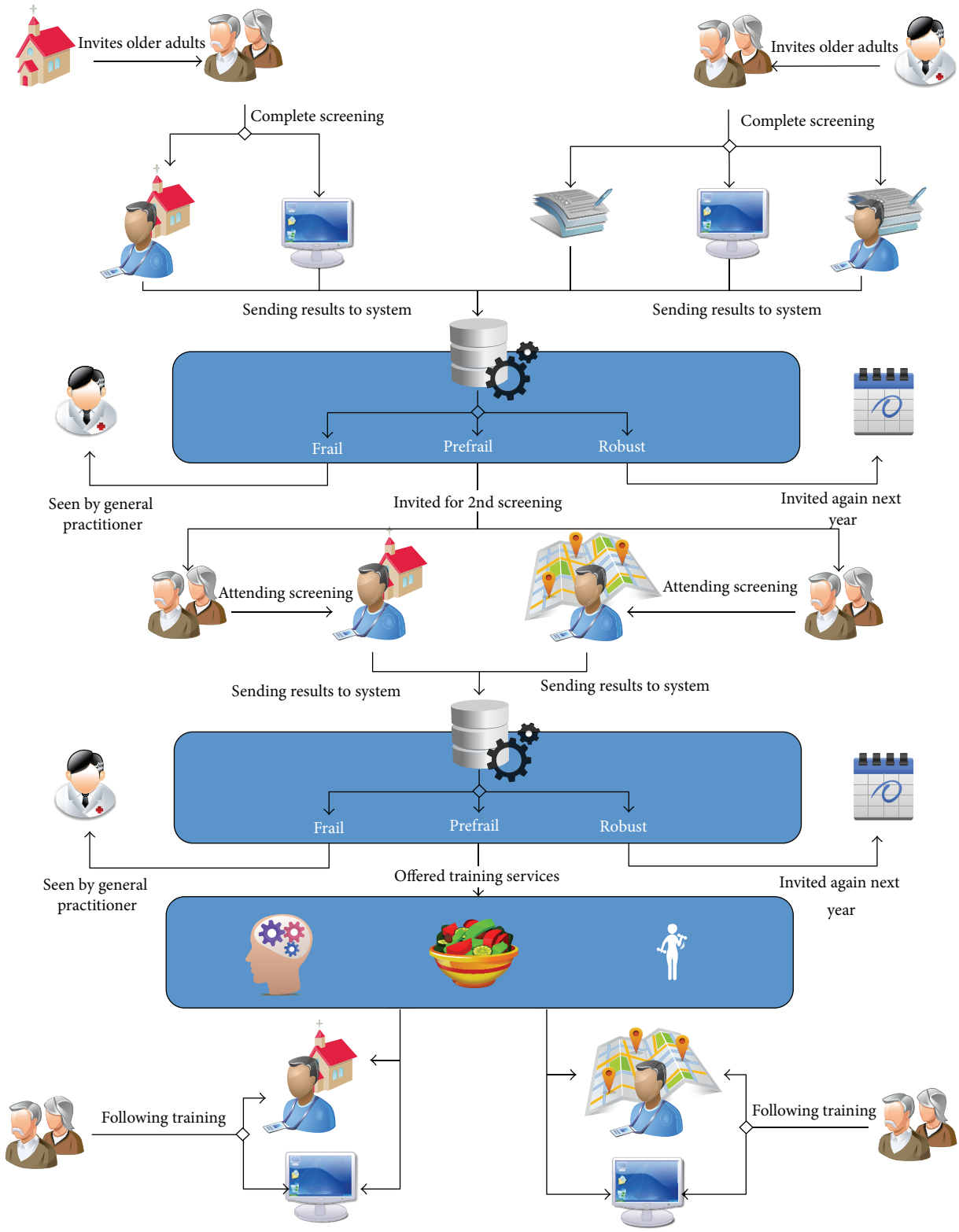

Figure 2: Service model.

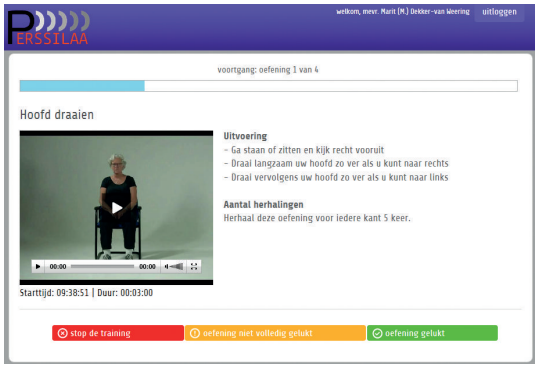

Figure 3: Screenshot of the service for training physical functioning.

a new screening a year later. An individual is classified as prefrail when limited decline is identified on at least one of the following three domains: nutrition, cognition, or physical status. These prefrail individuals are invited for a second screening. The second screening is administered by a trained volunteer at the church (Italian context) or by a trained student at different locations in the community (Dutch situation). This second screening consists of physical and cognitive tests, as well as some additional questions. Again, results are sent towards the database that, again, classifies every individual. This time, frail people are sent to a medical professional, robust people receive an invitation for a new screening a year later, and prefrail individuals are offered training services (for training physical or cognitive functioning or to educate people about healthy nutrition for older adults). These training services can be used at home via an online service. See Figure 3 for a screenshot of the service for training physical functioning, where people are instructed to do exercises via video, audio, and text. Alternatively, in Italy older adults can make use of the training services at the church and in Netherlands at the same locations in the community at which they could join the screening.

4. Discussion

In this paper, we have discussed how we have created a community-based, technology-supported service model for the detection and prevention of frailty among older adults. We applied a participatory design approach to come to a useful model that easily aligns with working procedures and the designated context of work. In the service model, older adults are screened via different modalities (online, on paper, or in person at a location in the community) after which they are provided training services for improving their physical or cognitive functioning, or for educating them about healthy nutrition for older adults. These training services are also offered via different modalities (as online, self-service module or at locations in the community). Medical professionals (such as general practitioners and nurse practitioners) are informed about the medical status of each older adult but do not play an active role unless the situation calls for it.

The service model and the technology can be used as a basis for developing a similar service model in a wide range of regions, countries, or healthcare models. But when one embarks on implementing the service model, several steps need to be localized. The way in which older adults are guided towards the screening and training services needs to be adapted to the traditions, possibilities, and stakeholder needs in a specific region. For example, we found that in Italy, the church is one of the most suitable venues for inviting and helping older adults, the general practitioner should invite people, while trained students at different locations in the community can aid older adults in their training efforts. Other assumptions within the service model (how the General Practitioner should be informed about results, and how to integrate the novel services supporting the screening for frailty to the advantage of his routine activity and especially of his patients) should be checked. Ideally, this should be done by conducting stakeholder meetings in which the key players for a setting in which the service is to be implemented gather and discuss the adaptations that need to be made to the service model we presented. It could take a few meetings before consensus is reached, but the investment in terms of time and effort should be quite small. Specifically, we see the following issues that need to be discussed. First, one must assess how the service model can be streamlined with existing working procedures. One should especially determine which actor is most suitable for inviting older adults for a screening, and which actor(s) should host and support the local screenings and training services in the community. Second, as the different medical professionals in a region will want to be kept up-to-date about the results of the screening and progress of training, connections will need to be made between the online frailty service and database and the local medical information system(s). As it differs per country or even region which medical information systems are used, one will need to determine which system to connect to, how to make this connection, and how and to whom to display results from the screening and training in the specific medical information system. For example, in Netherlands, general practitioners stated that they wanted to receive the results of each screening to be incorporated into a patient's electronic health file as an episode with an ICPC code (for overall decline). Third, a business model should be created that specifies how all the different activities are financed and how all the stakeholders are rewarded for their efforts. Without such a business model, the service will not be sustainable beyond the point where seed money runs out.

The setup of the service model (with a special focus on technology-supported, community-based care) has the potential to be cost-effective. It provides easy access for older adults towards healthcare service (as they can access them online or visit them in their local neighborhood). Finally, due to the use of online tools for screening and training, the service can scale up easily. As a result of these advantages, the service model can be a solution for the challenges that healthcare is currently facing: to provide care to a growing number of older adults with fewer resources, all the while ensuring that people retain a good quality of life. Via this service model, care is moved from a reactive, cure-oriented

approach that is centered at medical institutions and medical professionals towards a prevention-focused model that takes advantage from patient empowerment, online services, and trained volunteers, in a health-aware, responsible community. Consequently, the demand on the healthcare system decreases, shifting to prevention and health promotion, while citizens take an active role in their health, are empowered in receiving the care they need in the form they want (online, in the community, or as a combination), and improve their overall health outcomes.

The use of participatory design with stakeholders and end-users has resulted in a service model that not only is innovative but also aligns with the context and working routines in which it is to be implemented. Apart from these benefits, their involvement has, as we have experienced, also other advantages. First, as they become not only consumer of the service but also creator, stakeholders and end-users are more willing to adopt the service model and associated technology. After all, it is also partly "theirs." Second, for many end-users, adopting a new service (especially one that is fundamentally different from the traditional healthcare services they are familiar with) requires a paradigm shift. In our study, we saw that the older adults need to realize they should not rely on a doctor to arrange everything for them but should seize control themselves. Involving end-users into design provides them with the opportunity to get used to the idea and to discuss it with their peers. Ultimately, this leads to an implementation context where end-users are more willing to accept a new service's starting points.

5. Limitations

The development of the service model was done in participation with stakeholders and end-users but focused on a hypothetical situation. Existing initiatives for detecting and preventing frailty are scarce, so all participants had to talk about and imagine a future scenario. It might well be that they missed barriers that hinder successful implementation and service delivery and the only way to identify these barriers is to implement, execute, and evaluate the service. Then, with the insights from this evaluation, the service model can be further improved.

As we mentioned before, the service model cannot be copied "as is" to a new region where working procedures and the implementation context are different. Instead, one should adapt the service model to fit a specific region following the steps we have formulated above.

6. Concluding Remarks

The service model that we have developed is unique in that it is the first to detect and prevent frailty by means of community-based, technology-supported services. As such, it marks a step forward in creating healthcare services for older adults that not only include care by professional caregivers to deal with acute problems but also lead to a set of healthcare services that prevent problems by integrating initiatives in the community with online services. Our next steps are to implement the service model in different regions in Italy, in Netherlands, and in EU, taking advantage of the Reference Site Collaborative Network of the European Innovation Partnership on Active and Healthy Ageing (all the while improving the service by taking into account the lessons that the actual deployment provides us) and to evaluate the services in terms of clinical effectiveness and adoption by stakeholders. This way, we can also assess whether the model lives up to its potential.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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Research Article

Picture Your Nursing Home: Exploring the Sense of Home of Older Residents through Photography

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The quality of the built environment can impact the quality of life and the sense of home of nursing home residents. This study investigated (1) which factors in the physical and social environment correlate with the sense of home of the residents and (2) which environmental factors are most meaningful. Twelve participants engaged in a qualitative study, in which photography was as a supportive tool for subsequent interviews. The data were analysed based on the six phases by Braun and Clarke. The four themes identified are (1) the physical view; (2) mobility and accessibility; (3) space, place, and personal belongings; and (4) the social environment and activities. A holistic understanding of which features of the built environment are appreciated by the residents can lead to the design and retrofitting of nursing homes that are more in line with personal wishes.

1. Introduction

For older people who can no longer age in place, nursing homes provide an alternative place of residence where care and assistance are offered by professionals. The needs and wishes of older residents in terms of the architectural quality of the nursing home environment should ideally be respected and implemented as much as possible. It is questionable whether the nursing home is a place where one feels at home which corresponds to how residents experience the environment in which they reside. Furthermore, such questions correspond to what is needed for residents to feel at home in the first instance, which, in turn, should be considered in the constant process of evaluation and action. Creating attractive nursing homes, from both setting and social perspective, in which residents can feel at home, is a core challenge of nursing home organisations, in particular, their care staff and facility managers [1–4]. Too often, existing nursing homes do not meet the needs of the current generations of residents, and this mismatch leads to suboptimal living conditions that are experienced 24 hours a day.

In order to create this form of environment, namely, a true nursing "home," it is essential to address the experiences and views of the residents in studies and empower the thoughts of these residents through a combination of inclusive design strategies [5, 6]. Despite the laudability of small-scale initiatives in healthcare [7, 8], (future) residents are often overlooked and not included in design and development processes.

In the second half of the 20th century, the design of nursing homes was conducted by experts in the field, and this isolated approach traditionally resulted in high-rise hospital-like buildings [2]. In such cases, the quality of the building

Table 1: Characteristics of the participants.

Participant	Sex [M/F]	Age	Marital status	Education	Limitations
1	M	84	Widowed	Primary education	Mobility
2	M	94	Widowed	Secondary education	Mobility, early dementia
3	F	85	Widowed	Secondary education	Mobility
4	F	88	Widowed	Primary education	Mobility
5	F	74	Widowed	Secondary education	Mobility, CVA
6	F	87	Widowed	Primary education	Mobility, hearing
7	M	95	Widowed	Higher education	Mobility, sight
8	F	64	Unmarried	Higher education	Mobility
9	M	78	Married	Higher education	Mobility, CVA
10	F	83	Widowed	Primary education	Mobility, psychiatric symptoms
11	F	62	Unmarried	Primary education	Mental/intellectual problems
12	F	67	Married	Secondary education	Mobility, psychiatric symptoms

was often expressed in terms of technological, functional, and economic requirements, and factors related to the residents were given less attention. A more holistic vision of healthcare is currently emerging which considers the consequences of the built environment on the well-being of the residents [2]. For instance, Van Steenwinkel et al. [2] conducted a study focusing on how the built environment contributes to a feeling of homeliness of older people living in different contexts in Belgium. Van Dijck-Heinen et al. [3] investigated the sense of home among permanent and temporary residents of nursing homes in the Netherlands. Both studies concluded that a sense of home is a multifactorial phenomenon which is highly influenced by environmental, social, and personal characteristics. When one experiences a positive sense of home, one might experience a feeling of familiarity [9]. Duyvendak [10] also uses the two metaphors "heaven" and "haven" to describe a sense of home in a better way. Heaven refers to a place where you can be yourself, feel connected with like-minded people, and perform your favourite activities. Haven is a safe, comfortable, predictable place. When referring to the characteristics of "haven," this is primarily associated with the physical environment [10]. On the one hand, there is an elaborate set of literatures related to heaven and how social interactions with significant others play an important role in experiencing a sense of home. The literature related to haven, on the other hand, which deals with the built environment and personal belongings, is less abundant [4]. Despite these research efforts, there is a gap in the literature with respect to what might "influence" a sense of home and the general well-being of, and according to, nursing home residents with physical limitations and gerontopsychiatric health problems.

Therefore, this study explores (1) which factors in the physical and social environment correlate with the sense of home of the residents and (2) which environmental factors are most meaningful. The goal of this study is to gain insight into the experiences and views of actual residents in order to understand their needs in relation to the design of nursing homes and in order to make these nursing homes more fitting and facilitating to the social context of residents. This study is part of a larger programme called "Nursing Home of the Future," which investigates the architectural, technological, and social aspects of future nursing homes and the sense of home of the residents [1, 11–13].

2. Methodology

A qualitative methodology was chosen for this study, comprising photography and in-depth interviews with nursing home residents, as a way to involve the least voiced people in our society through creativity and dialogue [5]. The Critical Appraisal Skills Programme's checklist for qualitative research [14] was used as a guide for this study. In the following sections we describe (1) the settings, ethics, and participants, (2) photography approach, (3) interviews, and (4) the data analysis.

2.1. Settings, Ethics, and Participants. In April and May 2014, interviews and the field study were conducted in two wards of the same nursing home in Eindhoven, the Netherlands, including 12 participants (Table 1). The study aimed to include both residents with physical limitations and gerontopsychiatric health problems in order to gain a more diverse set of results. The inclusion criteria for this research were as follows: participants had to be at least 55 years of age, had to reside in a nursing home for at least six months, had to be able to communicate in Dutch, had to be able to take pictures with a photo camera independently or with the help of (in)formal carers, had to be able to make a selection of important photos independently, and had to be able to participate in an interview of at least 30 minutes.

A total of nine residents with physical limitations (out of 25 who were asked to participate) and three additional gerontopsychiatric residents (who were selected by the care organisation) consented to their participation. Prospective participants and their relatives received an information letter from the principal care professional, which was approved by the hosting care organisation. Informed consent was obtained from the participants in conjunction with their initial family carers by signing the given consent forms. All documentation was treated anonymously. Moreover, no persons or images

of persons were included in these photos in a recognisable way. Participants were asked not to take explicit pictures or photographs of people who did not want to be photographed.

The personal data from the participants were obtained with a checklist, which was based on the Tilburg Frailty Indicator (TFI) [15], an instrument used to quantify the frailty of older people from their own perspective. The study population consisted of 8 females and 4 males. The age of the participants ranged from 62 to 95 years. Eight of the participants were widowed, two respondents were married, and two were unmarried. All participants were born in the Netherlands. The level of education varied from primary education only ($n = 5$) to secondary ($n = 4$) and higher education ($n = 3$). Eight participants indicated, using the TFI, they felt healthy, three participants had no clear indication of their overall health, and one participant indicated not feeling healthy. The duration of residence in the nursing home ranged from 8 months to 8 years. Every participant had a single-person room, with private sanitary facilities. The participants had stated that they were satisfied with their living environment.

2.2. Photography. As pointed out by Annemans et al. [16], we experience the built environment through our senses. Therefore, a visual research method was chosen for this study [17], in which people are interviewed based on photographs they have taken themselves with cameras supplied to them by the researcher. Radley [17] concluded that what pictures portray and what stories narrate are better thought of as versions of our experience of the world than as constructions of the world that we experience.

Photography is a method that has been used in research for decades and which allows participants to create a record of an event, capture a complex phenomenon, or tell a story through images [18–21]. As taking photos does not rely on language alone, it can be used with vulnerable populations who might not normally be included in research [18, 22], for example, in researching frail older persons and nursing home residents. Previously, photography methods have been applied in the domains of housing, communities, and the built environment [16, 23–28].

Images provide a lasting record of an event or in the case of this study an architectural or social scene, required to study the relationship of humans and their living environments. A photo only serves as a conduit to enhanced, thoughtful, and deliberative narrative, instead of as a replacement of words. Photography allows complex environmental, health, and social issues to be captured and then shared with other people [16, 18]. There are numerous photography methodologies available for researchers, including photovoice, photo-elicitation, and photo-production methods. As this study tries to capture the real-life experiences of nursing home residents, the photo-production method was applied, which builds on the principles of photo-elicitation [17]. In line with Annemans et al. [16], this study wanted to gain a good understanding of what has been made visible on the photos, in addition to why and how. The photo-production method enables researchers to experience a phenomenon from another point of view, in this study, the nursing home as a living environment. The older residents, who serve as participants, are experts of their own situation and environment, and they can highlight the positive and negative features in the built environment.

Studies by other researchers, for instance, Yuan and Dong [28], suggest that asking older people to make pictures to document their experiences is not always straightforward. In this study, the selection procedure, the instructions, and manual were tools to tackle potential operational challenges.

At the beginning of this study, the participants received a short explanation of the goal of the study and how to use the camera, including a leaflet-sized written and visual manual on how to use the camera. The manual also contained the study's time plan, its goals, and contact details of the principal researcher (M. M. Verhagen). The participants were asked to share their experiences and views concerning their living environment and which of the factors of the living environment were most and least meaningful, through taking photographs of characteristic elements and situations.

The research team chose to provide the participants with disposable cameras instead of digital cameras for three reasons. First, traditional cameras may be more familiar to the participants, as is stated by Novek et al. [29], and can be operated as long as residents have sufficient strength and dexterity in their hands. Second, disposable cameras are cheaper than digital cameras and when dropped are not as easily damaged. Third, using disposable cameras limits the number of pictures participants could take, limiting the choice in the selection procedure. A disadvantage of disposable cameras is that pictures need to be developed, which is time consuming and costs money and one does not know the end results immediately. Digital cameras yield digital output, which is easier to process for data analysis. Moreover, participants may be less cautious with the disposable camera as they know it is of a lower value. With both methods, pictures can be supplied to the participants after the research as a token of appreciation of their contribution to the research.

In this study, participants were supplied with a camera for one week up to a week and a half (in late April and early May 2014) and were asked to take pictures of their living environment. The reel of the camera contained 27 photos, which should be sufficient for taking the most important pictures, but participants were free in the number of pictures they took. The participants did not keep a log of the things they photographed, although the researchers were aware that due to privacy restrictions not every situation could be photographed [30]. Even though notes from the logs could be used during the elicitation process, we assumed that the limited number of pictures would not require a log. Support, for instance, by family carers, could be provided to the participants for taking the photographs, but the decision to take a picture and the choice for scene that was to be photographed had to be that of the participant. After the time period, the cameras were collected by the principal investigator and sent off for development of the photos. Upon completion, the principal investigator returned to the participants and invited them to choose a top-5 ranking of their photographs. The top-5 ranking was used as a basis for the interviews held by the principal investigator in May 2014, as participants could use the selection as

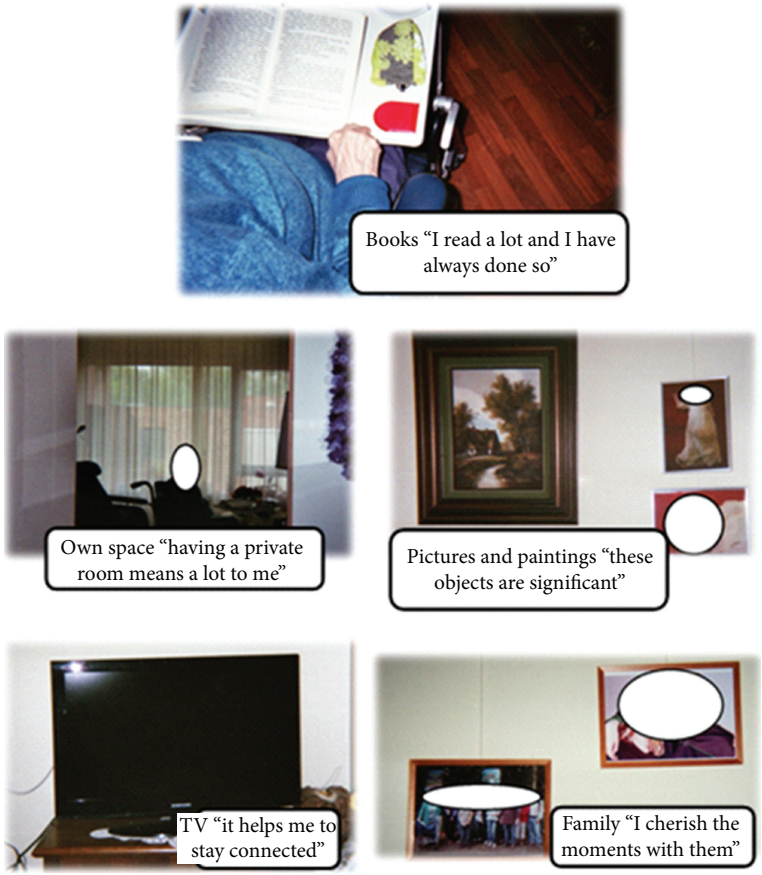

Figure 1: Example of the top-5 pictures of one of the participants, showing personal belongings, a private room, and social relationships. The top-5 ranking does not necessarily show building-related photos only.

a foundation for what they wanted to discuss in the interview [31].

2.3. Interviews. During the subsequent photo-elicitation interviewing phase, participants talked about the photographs and how they attributed social and personal meanings and values to these photographs. All interviews were conducted within the private rooms of the residents. The interviews had the character of a conversation in which participants were asked about their experiences and views of their living environment and their sense of home. The interviews varied between 30 and 60 minutes each, depending on the richness of the conversation and the attention span of the participants.

Each interview commenced with an introduction and participants were asked about their personal background, the reasons for admission, and health status (Table 1). The opening question included whether participants could describe their experiences concerning their living environment in general. Thereafter, the top-5 photographs taken were discussed in terms of the contents of the photographic material. This resulted in participants being asked to describe why the particular pictures were selected and the meaning of the pictures to the individual. The top-5 ranking was supplemented by items from a topic list, which is an overview of research themes and accompanying questions. The list was based on the work of Van Steenwinkel et al. [2] and van Dijck-Heinen et al. [3]. The participants were free to add items to the topic list, as long as these were relevant to the study. The topic list contained items relating to the living environment, such as (1) appreciation (choice, most meaningful features), (2) the choice for the top 5 (choice, meaning, positive features, and improvements), (3) experiences, wishes, and expectations of the living environment, (4) experience of the sense of home (which experiences, positive experiences, and improvements), and (5) experiences in relation to the living environment (which experiences, positive experiences, and improvements).

2.4. Data Analysis. All interviews were recorded with a voice recorder and transcribed verbatim. The data were analysed based on the six phases by Braun and Clarke [32]. First, all transcripts were read in their entirety. Then, the top-5 photographs were compared to the transcripts (Figure 1), which were used in conjunction with the photographs, and were evaluated in terms of the values that are attributed to the statements made by the participants and the photographs they had taken.

For instance, were these statements either positive or negative? Then, the first set of codes was being generated through open coding. Thereafter, codes were added to the transcripts. The researchers, bearing the research questions in mind,

systematically highlighted the relevant information (open coding). Open coding concerns the process of unravelling all of the collected data into fragments or codes. Similar codes and quotes were clustered and labelled, and themes emerged from this process. Together, the research team organised the codes and clustered them into smaller thematic groups. The final themes were grouped in amalgamation with the photographs that reflected aspects of these themes, which is a form of axial coding. Thereafter, these themes were reviewed and then defined and named. In order to guarantee the anonymity and privacy of participants, the photographs showing people were processed in order to white out faces. Names of people and institutions, appearing in quotes, were deleted from the written texts or were changed.

3. Results

There are numerous factors and subfactors which influence the sense of home. The thematic analysis led to the identification of four themes: (1) the physical view; (2) mobility and accessibility; (3) space, place, and personal belongings; and (4) the social environment and activities. These themes are further elaborated in the following sections.

3.1. The Physical View. The theme named the physical view encompasses the green environment in which the nursing home is located and the views from the building. Every participant stated that they appreciated the green environment of the nursing home, which is located in a park landscape. Living amongst nature is considered a positive perspective. A number of residents stated that the environment is beautiful, healthy, and green. This does not mean that all residents can appreciate the landscape by going outside, but in such cases the view of nature is considered to be attractive and pretty. To some, the green environment provides a sense of freedom. In total, the green environment was placed four times at the top 5 of photographs by the residents and the view from the nursing home five times. Three out of twelve participants mentioned the green environment. Words association with the green environment included "enjoying," "healthy air," "freedom," and "nice and green."

> *A green environment. Yes, it is healthy and beautiful, isn't it? [. . .] It is so nice, well, you need to enjoy it, I can really enjoy it. I always say that it is the small things that matter. That is the way it is, and you need to appreciate that. (Participant 5)*

Seven participants mentioned the view. Word association with the view included "beautiful," "nice," and "freedom." One of the participants talked about the photo she took staring out of the window, which she experienced as freedom.

> *I always look outside from the window over there. Freedom, aren't I allowed to say that? (Participant 1)*

Participants did not make a distinction between the types of view from the room. Any type of view was appreciated in this study, whether it was a park, traffic, a playground with children, or a building. The main reason for appreciating the view was that it gives them something to look at during daytime.

> *It is beautiful view, over this piece of art, the water tower. (Participant 9)*

A regular feature was the importance of birds. At one of the living rooms in the gerontopsychiatric ward there was a wild crow, eating from a net of peanuts hanging in front of the window. One of the respondents stated that this bird was the main source of distraction and a "resident of the ward" as if it were a pet animal.

3.2. Mobility. Several participants spoke of elements which can be classified within the theme of mobility, which relate to freedom, independence, and interior design. One of the residents spoke of the elevator, which is hard to operate when seated in a wheelchair. The hoist was mentioned as being an essential element in the room in order to be comfortable and to aid getting out of the chair. The bathroom can be a source of joy, if people can access it without difficulties, and they can wash and shower themselves. Another participant spoke of the washbasin in her room, which is hard to use, and therefore, it was photographed.

> *Yes, this one is about the sanitary equipment. You need to have a decent washbasin . . . one of those washbasins for the disabled, so to say. So you can wash your hands without having to stretch to absurd proportions. (Participant 8)*

> *A little difficult, isn't it? It, of course, does not feel like living at home, but on the other side it is pleasant to have someone around the corner when you need to go to the bathroom, so to say. (Participant 6)*

Two participants indicated that the taxi service was important in order to travel to places such as the supermarket and to see relatives. One of the participants stated that the waiting times are often too long, although they should be around 30 minutes at the most.

> *I'm happy that there is a taxi service. It opens the way to somewhere else. But things don't go smoothly. (Participant 9)*

Participant 7 showed a picture of him being lifted out of the bed. The hoist was named "James," in analogy to a butler, but the respondent said there was nothing interesting about the technology itself. No special meaning was given to the hoist, other than that it supported the personal mobility of the participant.

In relation to mobility, being dependent and the lack of freedom were the least appreciated features in the lives of the residents. One of the participants mentioned their wish to be able to walk again, because it would improve their sense of being independent. One of the respondents mentioned the feeling of not being able to do things alone and thought that this aspect was the worst of living in a nursing home. One of the female residents took a picture of her diseased

hands (arthritis) and described them as a source of "sadness." Another resident stated that having to sit all day makes one feel dependent on others, because one has to ask others to do things for them, and another one felt locked-up occasionally.

> *The nursing home, it is something you have to experience yourself for once. Having to sit here all day, being dependent, having to ask for everything. It is hard to cope. (Participant 4)*

> *Well, I cannot say that I always enjoy myself, but that is more a matter of my character than of the environment I think. [. . .] Yes, I do feel locked-up once in a while. (Participant 7)*

One participant stated that he had lost the sense of freedom because he was no longer allowed to drive around in a mobility scooter, which also emerged in the theme of mobility.

> *Yes, because of the mobility scooter that was taken away from me, I lost a great part of my freedom. (Participant 7)*

3.3. Space, Place, and Personal Belongings. Many photographs were taken by participants based on pieces of furniture or personal belongings that are present in their room. The theme also concerns being able to decorate their own room and deciding which personal items are important in this process. Three of the participants took photographs of their television set. These residents cannot think of having to abandon the television, as it helps them get through the day and to keep up to date with the world news. This is actually one of the few comments about technology by the residents.

A regular feature was the importance of flowers. Flowers contribute to a homely atmosphere, as was acknowledged by multiple participants. Drawings of grandchildren meant a lot to the participants, because they represented memories of loved ones. One of the residents explicitly stated personal belongings and having a nice chair are important to her.

> *Yes here, the fact that I have a comfortable chair and many of my personal things. That is something I like. (Participant 6)*

Having access to either a single-person room or an allocated space in the communal areas is subthemed as having a private place in this study. This theme emerged from the analysis of the photographs. Five participants took photographs of their own private place. This was either their own room (4 participants) or a place somewhere else in the nursing home. Additional pictures were taken of picture frames with smaller photos of the relatives, which were found in the private rooms. During meal times, the residents have their own place around the table. The private room means pleasure and joy in living. One of the participants wished that their own room would have a more attractive atmosphere but has the impression that personal belongings and furniture would not fit inside. She does not know what the possibilities are for bringing items, and she does not want to burden others with having to carry loads.

> *I wish the room were bit cozier, but there is nothing at home that would fit in here. I have large cabinets, and I have a large clock too. It would be nice if I could put it here, but I don't bother to carry heavy loads. And a small cabinet as well, and a large one, but I am not sure whether it will stand in the way. We need space for the patient hoist and it would not be enough [with the cabinet]. (Participant 3)*

Two participants stated that living in the nursing home will never be like living at home but that they have accepted the situation and are satisfied. Two other participants stated that they do not experience a sense of home at all. One of the residents stated it feels like being in a shared student dormitory.

> *Do I have to give a grade for it? Well, I don't have a sense of home. It feels like I live in a student house, we are going back to our teenage years, living in a room and getting pocket money. (Participant 5)*

For one of the participants, the common living room is the main source of a sense of home. Two of the participants stated that they would rather return to their old home. They did realise that this was no longer an option. Four of the participants stated that the way they are being cared for positively contributes to a sense of home. Two residents experienced a sense of home inside of their private rooms.

> *Because I am rather mobile, and have my own stuff around, I do feel at home in my room. (Participant 6)*

One participant mentioned the entrance as being important. She calls the entrance her private spot and forms a sense of mental freedom. Residents may have a sense of being locked.

> *The entrance is important. Because it is also the exit. (Participant 5)*

> *Without this little place, I don't make it through the day. There is a lot of buzz. (Participant 10)*

Finally, one of the participants mentioned the cleaning tools and products in her room. The meaning of these items was a sense that the room was kept clean and tidy. She was worried that the current cleaning regimen of cleaning twice a week was reduced to once a week, which she considered to be insufficient.

3.4. Social Environment and Activities. The theme named social environment and activities encompasses the contacts with care professional and relatives and being engaged in activities. The participants indicated a great appreciation for the care staff; in particular, the personal contact and the treatment were considered positive. A number of participants indicated that they valued their contact with relatives as most positive, in particular, having close contacts and being visited on a regular basis.

A number of times, participants spoke of their interaction with care professionals. Five out of twelve participants stated that these professionals contributed positively to their quality of life. One of the participants took a picture of herself with a care professional. It was perceived important to have a positive personal contact with the caregiver and being able to get along well with them.

> *Well, yes, the contact with the care professionals. Well, yes, you need to be on speaking terms, so we can get along well. (Participant 9)*

Five of the participants mentioned the importance of relatives during the interviews and included spouses, children, grandchildren, great grandchildren, parents, and siblings. One of the participants mentioned that he appreciated that his wife came to visit him every day at 18:00.

> *The fact that my wife comes visit me every day is the thing I appreciate most. (Participant 9)*

A number of participants spoke about the activities that were being organised, such as the cooking club, arts, and crafts such as paint workshops, and reminiscence activities conducted in the activity space. One of the residents spoke of the small shop on the ground floor which keeps her occupied and allows her to buy clothes. Two others indicated missing a large store in the direct neighbourhood for buying groceries.

> *Oh that is so nice. I had to go to the small store a while ago. If I cannot buy the things I want, they will actually buy it for me. (Participant 10)*

Having dinner is an ingredient for employing a nice atmosphere to multiple participants. One of the participants took a photograph of a Chinese meal, which he found illustrative of the atmosphere and the memory he had of the dinner. Another participant took a photo of a quality restaurant and the quality food that was served there. She said she missed good quality food in the nursing home. In the two wards of the nursing home, food and drinks were experienced differently. Food, to the participants, is related to appreciation of the living environment which is a positive or negative sense.

> *Sometimes, the food is alright, and at other times it is very bad. I have the choice between two meals, and I guess I always chose the wrong meal. (Participant 7)*

> *I appreciate the food the most. It looks so tasty and it actually tastes good. People told me I was getting served wartime meals; well these meals were definitely not served during the war. It is all rubbish what they said. (Participant 10)*

A number of residents valued the dining atmosphere, especially in relation to being seated around a table together.

> *Particularly going to the dining room is nice. We all sit together around a table with certain people. The table is nicely set. You sit around the table like you used to do at home. (Participant 2)*

4. Discussion and Conclusion

4.1. Reflections on the Results. The focus of this study was the sense of home. This is a complicated and multifactorial phenomenon, which contributes to a sense of identity and well-being of nursing home residents [3, 33–35]. The themes which seem to have a relationship with the experienced sense of home in this study seem consistent with the findings of Sixsmith [36]. In this study, 22 adults were questioned about which factors were associated with their experienced sense of home. 20 categories were formed which were categorised into three layers of perceiving a home, namely, physical, social, and personal.

Feeling at home is a layered emotion [10], and in order to experience a sense of home, one should feel familiar within the environment. A home can either be a country, a city, a neighbourhood, a house or a park bench [9], or, in the context of this study, a nursing home. This, however, does not mean that it is a naturalness that nursing home residents experience a sense of home by just the fact that they live in such a facility. Not all of the residents in this study felt at home, even though they could point out factors in the environment that were important to them. The feeling, that is, the sense of home, that we are talking about is a secondary emotion, and this is a conscious experience of the experienced "more reflexive" primary emotions [37]. Additional emotions play a role, which can differ per individual and one's circumstances. Our study showed that certain social events, including having meals together with fellow residents, contribute to positive emotions that, in turn, positively contribute to their personal sense of home.

A well-experienced balance between autonomy and safety/security also contributes to a positive sense of home [2, 38]. In this study, residents express concerns and limitations related to their sense of autonomy, for instance, when speaking of the need for assistance and help with mobility. At the same time, the sense of security is also hampered in the nursing home, as people are dependent on others for help. In the words of these residents, their sense of home is affected in a negative fashion. This can be explained through the nature of nursing homes, in which more emphasis is put on the provision of a safe and secure environment, whereas residents like to see an environment in which their personal autonomy is enhanced. If a person does not experience a good sense of home, he or she may feel anxious and uncertain [9], and this, in turn, may be aggravated by the fact that the sense of autonomy and security in a nursing home environment may be lower than that for people who still live in their own homes. Duyvendak [39] also reported that people can feel homesick and nostalgic when they experience a lack of sense of home. One's own home can be seen as a secure place from which they can explore the world around themselves [2]. By furnishing one's home with personal belongings, for instance, one enables reminiscence and positive memories [2, 34, 40, 41]. In this study, residents mentioned the importance of personal belongings as a way to connect with their past and as a source of familiarity.

4.2. There Is More to It Than Just the Built Environment. When architects design buildings, it is often thought that the built environment and the architectural design dictate how people experience the space and the interactions that will take place. To residents, the built environment may be of a different level of importance compared to the more basic needs and a well-functioning and stimulating social environment. This does not rule out the need for age-friendly solutions and accessibility. Primarily, residents value good communication with care professionals and relatives the most, as well as having a sense of autonomy, independence, and freedom. These are all human values. This is in line with findings from a review by Xu et al. [42] on the quality of life in relation to nursing home features. The researchers concluded that there were serious questions about whether any elements of the nursing home's structure can improve residents' quality of life. Rural facilities (green environments) and facilities with a higher percentage of private rooms had better residents' self-reported quality of life. This is in line with the statements by the residents that they valued a green environment. Moreover, it suggests that the built environment has a role to play in the quality of life of older people but that the social environment should also be considered when planning and designing a new facility.

According to Brown et al. [24], place attachments are the positive bonds that people form with places and which arise from affective, behavioural, and cognitive ties between individuals or groups and their sociophysical settings. The built environment cannot be seen on its own without regarding the social context. Moreover, place attachments can also change, as old attachments evolve or are disrupted and new attachments form [24]. Admission to a nursing home is a major life-event, as most individuals do not wish to leave the home they have been living in for a long time in order to move to a nursing home [43]. Nevertheless, "*there seem to be good reasons to assert that living in an institution and being 'at home' is not a contradiction in terms*" [44, page 221]. In this study, residents spoke of (social) activities that took place in a certain room or part of the nursing home, for instance, eating in the communal living room. These activities and spaces were mentioned at the same time, as if they were linked together. The activities were the main contributor to the development of a sense of home and may be a starting point to improve living conditions for people who have been admitted to a nursing home.

Still, features of the built environment have a role to play. Features of the built environment that matter are the green environment, the view from the rooms, and having personal belongings in a private room where residents can withdraw. When these important features of a nursing home are present, residents have a basis to develop a sense of home. Moreover, these features are within reach of architects designing nursing home facilities. It is, therefore, an important task for architects to create environments which meet the needs of future residents and may even contribute to social interaction, for example, by designing rooms where one can meet up and interact with others and where visitors are invited and feel welcome. The need for having both social and architectural components which have to be fulfilled in order to get a sense of home matches the findings by Van Steenwinkel et al. [2] of people who resided in the community. In our study, participants indicated that having flower arrangements and having a positive and homely atmosphere and habits, like eating together, are important for experiencing a sense of home. These statements are in line with earlier findings by Cooney [45].

What this study has shown once more is that nursing home residents are independent and unique in their needs and wishes. It is important not to offer standardised arrangements for nursing homes. Instead, residents should have the freedom to live the lives they want to lead and make changes to their room (by adding personal belongings) without hampering the provision of care. People in general express their sense of identity through their personal belongings [10, 46], and these belongings can "move" the sense of home to the nursing home environment [47]. Relatives can play a role in the development of a sense of home in the nursing home, for instance, in eating together, decorating their room, saying goodbye to their former home, and the creation of a new home together with other residents. The photographs and outcomes of the interviews may actually act as the stimulus for social action and change [48]. In line with such actions, it should be interesting to explore the degree of freedom a nursing home resident has in relation to making modifications to the home environment or private room.

4.3. Reflections on the Methodology. The methodology applied in this study can be utilised across a wide range of settings, including older people with dementia, with autism, and with cognitive impairments. People have a strong visual tool to express wishes and needs, when words are often too limited to describe how people think or feel about something. In fact, the methodology could also be expanded to indoor environmental research and studies concerning building services engineering at home and in office buildings. The photographs allow for a direct and complete expression of thoughts and expressions and provide a qualitative methodology which is not entirely new to the field [16, 28, 49] but is not applied on a large scale in nursing homes. There are some things that can be improved in future studies concerning nursing home residents.

First of all, the researcher could undertake the photography in conjunction with the participants and conduct the interviews directly afterwards or even during the photography sessions. The participants will be able to remember why a certain picture was taken in the first instance and provide a better description. This is particularly true when it takes some weeks to have the photographs developed (as traditional photography is getting out of fashion and is no longer optimally supported by the market chain). Using a digital camera is more costly but solves the challenge of having to wait. In addition, using disposable cameras resulted in half of the photographs being blurred and, therefore, not useful for the study. When dealing with poorly taken photographs, one could ask for making top 5 without the photographs but by describing what has been photographed

in order to find answers to the research question. When taking photographs together with the participants, one can do a secondary check with the participants by again showing the photographs and the transcripts in a later stage as a form of member check. Given the small sample size of the current study, it would be recommended to work with larger groups. This would also allow for the application of the so-called photovoice methodology [17] in which themes can be found through interactions in a group.

4.4. Conclusions. The major challenge for practice is how to incorporate the factors identified in this study in the design and planning of the built environment and how to stimulate social interactions in order to improve the sense of home of residents. The residents' sense of home is not similar to the design of housing alone. The implications thereof are that improving a sense of home is a multifactorial assignment in which many factors need to be addressed and that it encompasses more than just a good design of the built environment. This is also reflected by the statements of the residents included in this study, as a sense of home was not experienced by all of them. The treatment by others, including relatives and care professionals, is another important factor that is valued and has an impact on the sense of home.

The improvement of the experienced sense of home can be achieved through the residents themselves on the one hand and the care professionals on the other hand, for instance, by making changes to the built environment and social interactions. An inclusive approach to the design of nursing homes can combine creative and interviewing techniques which help create an ideal home situation. It can provide a way of participation for the least voiced. In the future, nursing home organisations and family carers could engage in similar creative methods in order to find out which aspects of the built environment are appreciated most and how rooms should be designed and decorated. This would be a method to stimulate social change which is inclusive.

Disclaimer

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Conflict of Interests

There is no conflict of interests.

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Research Article

Is Self-Reported Physical Activity Participation Associated with Lower Health Services Utilization among Older Adults? Cross-Sectional Evidence from the Canadian Community Health Survey

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Purpose. To examine relationships between leisure time physical activity (LTPA) and health services utilization (H) in a nationally representative sample of community-dwelling older adults. *Methods*. Cross-sectional data from 56,652 Canadian Community Health Survey respondents aged ≥ 50 years (48% M; 52% F; mean age 63.5 ± 10.2 years) were stratified into three age groups and analysed using multivariate generalized linear modeling techniques. Participants were classified according to PA level based on self-reported daily energy expenditure. Nonleisure PA (NLPA) was categorized into four levels ranging from mostly sitting to mostly lifting objects. *Results*. Active 50–65-year-old individuals were 27% less likely to report any GP consultations (OR_{adj} = 0.73; $P < 0.001$) and had 8% fewer GP consultations annually (IRR_{adj} = 0.92; $P < 0.01$) than their inactive peers. Active persons aged 65–79 years were 18% less likely than inactive respondents to have been hospitalized overnight in the previous year (OR_{adj} = 0.82, $P < 0.05$). Higher levels of NLPA were significantly associated with lower levels of HSU, across all age groups. *Conclusion*. Nonleisure PA appeared to be a stronger predictor of all types of HSU, particularly in the two oldest age groups. Considering strategies that focus on reducing time spent in sedentary activities may have a positive impact on reducing the demand for health services.

1. Introduction

The importance of physical activity (PA) in reducing chronic disease and maintaining good health and functional independence has been well documented [1–5]. The health benefits of exercise, including enhanced cardiovascular functioning, improved glucose tolerance, and obesity reduction, are well known [1–3, 6]. Improvements in conditions such as osteoporosis, sarcopenia, and certain forms of cancer [1, 2, 4, 5, 7], positive changes in mental health, particularly related to depression and stress management, and improvements in cognitive ability, quality of life, and well-being [4, 5] have also been linked to increased PA levels. Although the importance of being physically active is widely acknowledged among the Canadian population, levels of physical activity remain low, particularly among older adults, with fewer than 15% attaining the recommended 150 minutes per week of moderate-vigorous PA [8, 9].

Physical inactivity among older adults is of particular concern in many industrialized countries, including Canada,

because of the important societal implications associated with population aging [10]. By 2036 it is expected that 1 in 4 Canadians will be 65 years of age or older, the majority of whom will have at least one chronic condition [11–13]. Given that the average life expectancy at 65 years of age is now 21.5 years for women and 18.3 years for men, a significant proportion of the population will require ongoing, long-term medical care to manage their conditions [14]. There is great concern that the increasing chronic care needs of older adults will place considerable strain on the health care system, in terms of both its capacity to meet an increasing demand for services and its ability to sustain the current level of service provision in the face of increasing costs [15, 16]. Among policymakers and health providers alike, there is growing interest in the potential role of PA as a strategy to mitigate these challenges [10, 17, 18].

Physical inactivity has been shown to be positively associated with health service utilization and costs; however, the literature in this area is quite limited, particularly as it pertains to older adults [19, 20]. Recently published estimates of the economic burden of physical inactivity indicate that between 3.6% and 3.8% of total health care costs, or $6.8 billion, can be attributed to physical inactivity in Canada [21–23]. Studies examining the relationship between PA and health services utilization among older adults have shown mixed results. Woolcott et al. [24] compared "general health visits" (including general practitioner and specialist physicians as well as other health care providers) between active and inactive respondents in a nationally representative sample of 24,281 older adults aged 65 years and older. In this study, physically active seniors reported significantly fewer "general health visits" than their inactive counterparts (8.15 versus 11.76 visits/yr). In contrast, Plotnikoff et al. [25] found that PA was not significantly associated with either general practitioner (GP) or specialist visits in a sample of 2300 individuals with type 1 diabetes (T1D) or type 2 diabetes (T2D).

The results of studies of PA and hospital services utilization are also somewhat inconsistent. Sari [26] recently examined the association between PA and the demand for hospital services in adults who are 65 years of age and older and found leisure time PA (LTPA) to be inversely associated with hospital stays, concluding that even small increases in LTPA could translate into a decrease in hospital stays of 16% to 19% in inactive older adults. In a similar study, Woolcott et al. [24] reported that physically inactive older adults were 84% more likely to be hospitalized in the previous 12 months and spent, on average, more than three times the number of days in hospital compared to their active counterparts. In contrast to these studies, Plotnikoff et al. [25] failed to find a significant association between LTPA and the number of hospital visits in their sample of adults with T1D and T2D, after adjusting for other factors associated with health services utilization.

Although these studies are encouraging, there remain considerable gaps in our understanding of the relationship between physical activity and health services utilization, particularly among older adults [20, 27]. Along with the general lack of Canadian data, wide variations in study methodologies limit the extent to which we can draw conclusions from the literature [20]. The purpose of this study was to examine the relationship between PA and health services utilization, while controlling for a comprehensive set of observed covariates, in a nationally representative sample of community-dwelling adults aged 50 years and older in order to gain better insight into the relationship between physical activity and health services utilization.

2. Methods

This study involved a secondary analysis of data from Cycle 3.1 of the Canadian Community Health Survey (CCHS). The CCHS is a nationally representative cross-sectional health survey designed to provide information related to health determinants, health status, and health services utilization for the Canadian population aged 12 or older [28, 29]. Access to the confidential microdata files for Cycle 3.1 of the Canadian Community Health Survey (CCHS) was carried out through the Saskatchewan Research Data Centre at the University of Saskatchewan following an evaluation of the proposed research by the RDC-Access Granting Committee.

Data collection for CCHS Cycle 3.1 took place from January to December 2005 by means of computer-assisted personal and telephone interviews. In total 168,464 households were selected to participate. A response was obtained for 143,076 of the selected households, resulting in a household-level response rate of 84.9%. Of the 143,076 individuals selected (one person per household) to participate, valid interviews were conducted with 132,947 individuals yielding an individual-level response rate of 92.9%. When sample weights are applied, CCHS data represents approximately 98% of the Canadian population living in private and occupied dwellings in all provinces and territories [29, 30]. The present analysis was restricted to those respondents aged 50 years and older with nonmissing PA and health services utilization data, resulting in an unweighted sample of 56,652 adults.

2.1. Dependent Variables. Health services utilization was characterized as the use of general physician (GP) services, specialist physician (SP) services, and hospital services in the 12-month period prior to the survey. Both service contacts (services used versus services not used) and volume of service use were of interest because of the probable differences in the determinants of each type of utilization [31].

2.1.1. Physician Services. Respondents were asked to report the number of consultations, including telephone consultations, with GP and specialist physicians in the 12-month period preceding the survey [32]. In addition to two continuous variables indicating volume of service use (one for each type of physician), two dichotomous variables (use versus nonuse) were constructed to indicate the incidence of contact with both types of physicians.

2.1.2. Hospital Services. Two variables were used to describe the use of hospital services based on questions asking if the

respondent had stayed overnight as a patient in a hospital and the total number of nights spent in hospital in the preceding 12 months: a dichotomous variable indicating if the respondent had been hospitalized in the previous year and, for those respondents reporting a hospitalization, a continuous variable indicating the total number of nights spent in hospital.

2.2. Independent Variables. The main independent variable of interest was self-reported LTPA over the 3 months prior to the survey interview. Respondents were asked about their participation in 21 specified physical activities, participation frequency, and average activity duration, using an adaptation of the Minnesota Leisure Time Physical Activity Questionnaire (MLTPAQ) [32]. An index variable was used to categorize respondents as active (>3.0 kilocalories per kilogram per day; KKD), moderately active (1.5 to 3.0 KKD), and inactive (<1.5 KKD), according to the average daily energy expenditure as determined by the reported frequency, duration, and metabolic cost associated with all the leisure time physical activity [32].

2.3. Control Variables. The control variables included in the analysis were chosen *a priori* based upon the Andersen-Newman model of health services utilization [33, 34]. Within this framework, individual determinants of health services utilization are categorized as "predisposing," "enabling," and "need" factors, all of which are thought to influence the decision to seek medical care. Table 1 summarizes the predisposing, enabling, and need factors associated with health services utilization that were available in the CCHS Cycle 3.1 [29] and included as control variables in all statistical models. Selected environmental factors, including those related to the health system, the external environment, and the community, were also included, given their influence on health services utilization [35].

Table 1: Predisposing, enabling, health need, personal health practices, environmental, and community control variables included in the multivariate analyses.

Control variables	Factors
Predisposing factors	Age; gender; marital status; education; ethnicity; immigration
Enabling factors	Annual household income; employment status; speaks English and/or French; has regular doctor; household size; dwelling size
Need factors	Self-rated general health; self-rated mental health; injury in the previous 12 months; limitations in ADLs; number of chronic conditions; chronic conditions[†]; BMI classification
Personal lifestyle factors	Smoking status; exposure to second hand smoke; alcohol consumption; walking/cycling for transportation; typical daily physical activity outside of leisure time
Environmental factors	Province; urban-rural residence

[†]Specified chronic conditions include hypertension, cardio-/cerebrovascular disease (heart disease, stroke); COPD (emphysema, chronic bronchitis); asthma; diabetes; cancer (currently have/ever had); neurological conditions (chronic fatigue, syndrome, migraines, Alzheimer's, other dementia, epilepsy); rheumatological conditions (fibromyalgia, arthritis/rheumatism); back problems; gastrointestinal conditions (intestinal/stomach ulcers; Crohn's disease/ulcerative colitis/irritable bowel syndrome/bowel incontinence); mood/anxiety disorders; other mental health conditions (schizophrenia, autism/other developmental disorder, eating disorder); conditions not otherwise listed.

2.4. Statistical Analyses. All analyses were carried out at the Saskatchewan Research Data Centre using SPSS 19.0 (SPSS Inc., Chicago, IL) and STATA 10 (Statacorp LP, College Station, TX). To account for unequal probability of selection in the CCHS Cycle 3.1 due to the complex sampling design, sample weights were applied in all analyses in order to obtain population-based estimates [29]. Unless otherwise indicated, a significance level of $P < 0.05$ was applied.

In order to describe the characteristics of the study population, frequencies or means ± SD were determined as appropriate for all independent variables of interest. The sample was stratified on the basis of age and PA level into three age groups (50–64 years, 65–79 years, and 80 years and older) and three activity levels (active, moderately active, and inactive). The decision to stratify by age was made *a priori*, in recognition of the considerable heterogeneity within the demographic subgroups of the older adult population relative to PA, health, and health services utilization [15, 16, 26, 36].

Dependent variables were assessed separately for each age group. The distributions of all dependent variables were compared between PA groups using chi square and ANOVA for categorical and continuous variables, respectively. When the assumptions for these tests were not met, Fisher's exact test, Mann-Whitney U test, or the Kruskal Wallis test were used, as appropriate.

General linear modeling procedures were employed in order to assess the association between LTPA and each dependent variable. Multiple logistic regression models were used to obtain odds ratios (OR) describing the association between LTPA and the dichotomous variables indicating use or nonuse of physician services. Negative binomial (NB) regression modeling was used to obtain incident rate ratios (IRR) in order to assess the relationship between LTPA and the annual number of GP and specialist physician consultations [26, 37]. The association between LTPA and overnight hospitalizations and the total number of nights spent in hospital was assessed using ORs and IRRs obtained through multiple logistic regression and NB regression techniques, respectively. In all analyses, the reference group was the inactive category.

Bootstrap resampling procedures were used to produce corrected standard errors to calculate confidence intervals and to test for statistical significance. This technique is recommended for estimating sample variances in surveys with a large number of strata and multiple primary sampling units per stratum where exact design effects are not known

[38]. A bootstrap macro specific to the CCHS Cycle 3.1 was provided by Statistics Canada.

3. Results

Key sociodemographic, health, and lifestyle characteristics of respondents are presented by age group and PA level in Table 2. In the 50 to 64 and 65 to 79 years age groups, the majority of the population was married and had completed high school. Most respondents in the oldest age group were not married and although the majority had completed high school, this age group was more evenly split across education levels. Across all age groups, less than 5% of the population self-identified as Aboriginal. The vast majority were born in Canada and lived in urban areas (>66% and ≥79%, resp.).

With regard to income, more than half of older adults under the age of 65 reported annual household incomes greater than $30,000; however fewer than 30% of respondents over the age of 65 reported annual incomes exceeding $30,000 per year. Approximately two-thirds of the population aged 50 to 64 years and 10% of those aged 65 to 79 years were employed. The majority of respondents under the age of 80 years reported living in a household with two or more people while close to half of those 80 years and older lived alone.

The vast majority (>90%) of respondents reported having a regular family doctor and this increased with increasing age. With the exception of inactive respondents in the two oldest age groups, more than 80% of respondents reported their general health to be excellent, very good, or good; more than 90% of respondents, regardless of age group, reported their mental health to be at the same level. At the same time, close to 80% of respondents under the age of 65 and 90% of those over the age 65 reported having at least one chronic condition. In each age group, the proportion of active older adults reporting no chronic conditions was higher than in the inactive and moderately active groups. The most prevalent chronic conditions were arthritis/rheumatologic conditions (24.5%–56%), hypertension (21%–49%), back problems (17%–26%), and cardio-/cerebrovascular conditions (6%–31%). The prevalence of most conditions was higher in older age groups and lower with increasing PA. One notable exception was in the case of mood/anxiety disorders, where the prevalence was lower in the older age groups compared to the youngest age group.

With regard to personal health practices, the vast majority of respondents (>75%) were nonsmokers or former smokers and most (>65%) reported that they did not consume alcohol. Except for inactive respondents in the oldest age group, at least 50% of respondents reported spending, on average, more than 1 hour daily walking to work and/or to complete errands while fewer than 5% reported cycling daily to do the same. The majority of respondents (40%–59%) reported standing or walking as their usual or typical daily activity. In each age group, the proportion of respondents reporting their usual activity as sitting was lower as the activity level increased.

Descriptive data for all health service utilization variables, stratified by age group and LTPA level, are presented in Table 3. In all age groups, the number of GP and specialist consultations differed significantly ($P < 0.001$) between each LTPA level. With the exception of specialist consultations in the oldest age groups, the moderately active group reported fewer GP and specialist consultations than the inactive group and the active group reported fewer GP and specialist consultations than either the moderately active or the inactive group. The majority of respondents reported having between 1 and 4 GP consultations and no specialist consultations in the previous year. In the youngest age group, between 16.5% and 22% of respondents had no visits to their GP in the previous year while, in the oldest age group, fewer than 13% had no visits. Across all age groups, between 29% and 36% of respondents reported at least one contact with a specialist physician in the previous 12 months.

Across all age groups, fewer than 20% of individuals had been hospitalized in the previous 12-month period. The proportion of respondents who had been hospitalized was highest in the inactive group and lowest in the active group regardless of age group. The number of nights spent in hospital differed significantly ($P < 0.001$) according to LTPA level, with the number of nights in hospital decreasing with increasing LTPA, across all age groups.

3.1. Regression Analyses. The results of regression analyses are presented separately for each age group.

3.1.1. 50 to 64 Years Age Group. The results of the regression analyses pertaining to the 50 to 64 years age group are presented in Table 4. After adjusting for other factors related to health services utilization, active individuals in this youngest age group were 27% less likely than their inactive counterparts to have had contact with a GP in the 12-month study period ($OR_{adj} = 0.73$; $P < 0.001$). Being physically active was also associated with 8% fewer GP consultations over the 12-month study period (IRR = 0.92; $P < 0.01$). In contrast, moderately active and active 50- to 64-year-olds were as likely as their inactive counterparts to have at least one contact with a specialist physician ($OR_{adj} = 0.85$–0.94; $P > 0.05$) and were no more or less likely to be a high user of specialist services. Lastly, after adjusting for other determinants of hospital services ($OR_{adj} = 0.77$–0.93; $P > 0.05$) utilization, moderately active and active 50- to 64-year-olds were 8% and 3% less likely, respectively, to have had an overnight hospitalization in the previous 12 months; however, this was not statistically significant. Furthermore, LTPA was not significantly associated with the number of nights spent in hospital across activity level in this age group.

3.1.2. 65 to 79 Years Age Group. The results of the regression analyses pertaining to the 65 to 79 years age group are presented in Table 5. In this age group, no significant associations were found between LTPA and the use of either GP or specialist physician services. While the adjusted analyses showed that moderately active or active individuals did have 4% fewer GP consultations than their inactive counterparts (IRR = 0.96), these groups were 3% ($P < 0.05$) and 13%

Table 2: Population characteristics, stratified by age group and activity level (N = 56,652).

Predisposing factors	Age group 50–64 yrs. (n = 29,914)			65–79 yrs. (n = 20,183)			80 yrs. and older (n = 6,555)		
	Inactive (n = 15,393)	Mod. active (n = 7,882)	Active (n = 6,639)	Inactive (n = 11,109)	Mod. active (n = 5,027)	Active (n = 4,047)	Inactive (n = 4,772)	Mod. active (n = 1,101)	Active (n = 682)
Age (mean ± SD)	56.2 ± 4.2	56.4 ± 4.3	56.5 ± 4.2	71.5 ± 4.3	70. 9 ± 4.2	70.6 ± 3.9	84.2 ± 3.6	83.2 ± 3.2	83.0 ± 2.9
Gender (%)									
Male	49.3	47.9	52.6	41.0	47.4	57.8	31.0	41.4	52.9
Female	50.7	52.1	47.4	59.0	52.6	42.2	69.0	58.6	47.1
Marital status (%)									
Married	76.0	78.9	79.5	64.8	69.6	72.5	37.0	41.1	53.5
Not married/missing	24.0	21.1	20.5	35.2	30.4	27.5	63.0	58.9	46.5
Education (%)									
Completed secondary	76.4	84.4	85.6	52.3	63.4	67.1	44.6	55.1	59.1
<Secondary	20.7	13.2	12.2	43.3	33.9	29.7	49.0	40.4	36.5
Missing	2.9	2.3	2.2	4.4	2.7	3.2	6.4	4.5	4.4
Household income (%)									
<$15,000	5.8	3.8	4.1	9.1	7.2	5.7	14.4	9.4	9.9
$15,000–$29,999	29.4	24.0	23.4	49.4	47.5	47.5	45.4	44.4	44.2
≥$30,000	50.0	59.4	59.7	19.8	27.5	27.1	12.0	20.4	23.0
Missing	14.7	12.7	12.8	21.7	17.8	19.7	28.3	25.8	22.9
Employment status (%)									
Not employed	30.4	32.7	37.3	85.6	89.2	87.7	100	100	100
Employed	67.2	65.0	60.7	11.7	9.1	10.1			
Missing	2.4	2.3	2.0	2.6	1.7	2.2			
Has regular family doctor (%)									
Yes	90.3	91.8	90.9	94.6	96.1	93.9	96.2	96.6	95.4
No/missing	9.7	8.2	9.1	5.4	3.9	6.1	3.8	3.4	4.6
Self-rated general health (%)									
Excellent/very good/good	80.8	88.8	91.9	69.8	83.6	88.0	63.5	81.2	82.5
Fair/poor/missing	19.2	11.2	8.1	30.2	16.4	12.0	36.5	18.8	17.5
Self-rated mental health (%)									
Excellent/very good/good	93.1	95.2	96.7	93.7	96.6	97.0	91.0	95.9	95.3
Fair/poor/missing	6.9	4.8	3.3	6.3	3.4	3.0	9.0	4.1	4.7
Number of chronic conditions (%)									
None/missing	20.3	20.0	23.3	10.1	10.7	14.1	7.7	10.9	13.1
1 condition	25.1	28.9	30.3	17.4	21.3	23.9	13.7	19.3	20.1
2 conditions	21.7	22.0	22.3	21.8	24.9	24.8	20.1	23.8	26.7
3 conditions	23.8	21.9	17.7	37.1	30.7	26.6	41.4	34.3	26.5
≥4 conditions	9.0	7.2	6.3	13.6	12.5	10.6	17.1	11.7	13.7
Typical daily PA (%)									
Usually sitting	27.5	21.6	17.0	30.4	12.3	7.4	48.1	21.5	11.0
Standing or walking	43.2	46.1	48.0	48.2	58.1	53.8	40.9	56.9	58.9
Lifting light/heavy loads	28.5	31.7	34.6	20.1	28.7	38.0	9.0	20.5	29.3
Missing	0.8	0.6	0.4	1.3	0.9	0.9	2.1	1.1	0.8

Table 3: Health services utilization, stratified by age group and PA level.

	50–64 yrs. (n = 29,914)			65–79 yrs. (n = 20,183)			80 yrs. and older (n = 6,555)		
	Inactive (n = 15,393)	Mod. active (n = 7,882)	Active (n = 6,639)	Inactive (n = 11,109)	Mod. active (n = 5,027)	Active (n = 4,047)	Inactive (n = 4,772)	Mod. active (n = 1,101)	Active (n = 682)
GP consultations*									
Mean (SD)	3.5 (5.3)	3.1 (4.7)	2.7 (4.2)	4.2 (5.2)	3.6 (3.9)	3.3 (4.4)	5.4 (7.6)	4.4 (4.7)	3.9 (3.8)
None (%)	17.9	16.3	21.8	12.7	11.4	14.8	9.7	12.6	11.3
1 consultation (%)	20.2	23.4	23.8	14.4	16.9	20.8	11.0	14.4	16.4
2 to 4 consultations (%)	41.0	42.4	40.0	43.9	49.1	45.7	41.5	40.8	45.8
5 to 8 consultations (%)	11.8	11.3	9.2	16.1	13.5	11.7	19.0	17.3	16.0
9 or more consultations (%)	9.1	6.6	5.1	12.9	9.0	7.0	18.9	14.9	10.5
†Specialist consultations*									
Mean (SD)	1.1 (3.8)	1.0 (4.3)	0.8 (2.5)	1.0 (3.2)	0.8 (2.1)	0.8 (1.9)	0.9 (2.7)	0.8 (2.4)	0.8 (2.2)
None (%)	67.7	69.1	71.0	64.5	65.4	66.1	68.4	65.9	69.6
1 consultation (%)	13.9	13.8	14.5	14.9	16.4	15.8	12.3	15.8	16.8
2 consultations (%)	6.9	7.4	5.8	8.6	9.2	9.0	7.8	9.6	3.5
3 or more consultations (%)	11.5	9.7	8.7	12.0	9.0	9.1	11.4	8.6	10.1
Hospital admission in past year* (%)									
Yes	7.8	6.1	5.7	14.1	9.9	8.5	19.7	14.4	10.5
No	92.2	93.9	94.3	85.9	90.1	91.5	80.3	85.6	89.5
††Total number of hospital nights*									
Mean (SD)	9.2 (21.2)	9.3 (23.4)	7.2 (16.8)	11.0 (21.2)	9.4 (20.1)	8.0 (17.6)	13.4 (25.8)	10.3 (16.1)	9.7 (12.6)

†Specialist consultations include all specialist physicians except eye specialists.

††Mean number of hospital nights for individuals reporting a hospital admission in previous 12 months.

*Within each age group, PA groups were significantly different ($P < 0.001$) on all health service utilization variables.

Table 4: The association between LTPA and health services utilization in the 50 to 64 years age group (N = 29,914).

	50 to 64 years age group					
	Unadjusted			Adjusted		
	OR/IRR[a]	(95% C.I.)	Sig	OR/IRR	(95% C.I.)	Sig
GP services						
At least 1 GP contact						
Moderately active	1.12	(0.99–1.26)	0.061	1.01	(0.88–1.17)	0.854
Active	0.78	(0.70–0.88)	<0.001	0.73	(0.63–0.84)	<0.001
Number of GP consultations[a]						
Moderately active	0.88	(0.83–0.94)	<0.001	0.97	(0.92–1.03)	0.308
Active	0.78	(0.74–0.84)	<0.001	0.92	(0.87–0.97)	0.002
Specialist physician services[*]						
At least 1 specialist contact						
Moderately active	0.94	(0.86–1.02)	0.138	0.99	(0.89–1.09)	0.792
Active	0.85	(0.77–0.95)	0.002	0.99	(0.87–1.12)	0.882
Number of specialist consultations[a]						
Moderately active	0.93	(0.80–1.08)	0.339	1.01	(0.90–1.13)	0.858
Active	0.77	(0.65–0.90)	0.002	1.04	(0.90–1.21)	0.557
Hospital services[†]						
Overnight hospitalization						
Moderately active	0.77	(0.65–0.90)	0.001	0.92	(0.76–1.12)	0.416
Active	0.71	(0.58–0.86)	0.001	0.97	(0.77–1.23)	0.822
Number of nights in hospital[a]						
Moderately active	1.01	(0.69–1.49)	0.940	1.15	(0.94–1.43)	0.181
Active	0.78	(0.49–1.25)	0.303	1.03	(0.80–1.33)	0.816

[a]The estimate is an incidence rate ratio (IRR).

Note: analyses adjusted for the following (reference category in italics): age; sex (*male*/female); marital status (married: *yes*/no); education (graduated secondary: *yes*/no); ethnicity (*non-Aboriginal*/Aboriginal); employment status (employed: *no*/yes); household size (*1*, 2, 3, or more people); dwelling size (*<3 bedrooms*, 3 bedrooms, >3 bedrooms); immigration status (*nonimmigrant*, immigrant); injury in previous 12 months (*no*/yes); limitation in ADLs (*no*/yes); smoking status (*never smoked*/former smoker/nonsmoker); exposed to 2nd hand smoke (*no*/yes); alcohol consumption (*<1 drink daily*/at least 1 drink daily); BMI (*<25.0* kg·m^2/25.0–29.9 kg·m^2/≥30 kg·m^2 or greater); time spent walking to work or to run errands (*none*/<1 hour/≥1 hour); cycling to work or to run errands (*no*/yes); typical daily activity level (*usually sitting*/standing or walking/lifting light and/or heavy loads); annual household income (*<$15,000*; $15,000–$29,999; ≥$30,000; missing); province (*ON*, MB, AB, BC, SK, QC, NB, NS, PE, NL, YT/NT/NU); urban-rural classification (*urban*/rural); language (able to speak English and/or French: *yes*/no); has regular family doctor (*yes*/no); self-rated general health (*excellent/very good/good*; fair/poor); self-rated mental health (*excellent/very good/good*; fair/poor); diagnosed with hypertension, cardiovascular disease (including stroke), COPD, asthma, diabetes, cancer, neurological conditions, rheumatological conditions, back problems, gastrointestinal disorders, mood/anxiety disorders, or other chronic conditions (*no*/yes for each); number of chronic conditions (*none*/1 condition/2 conditions/3 conditions/4 or more conditions).

[*]Analyses of specialist services also adjusted for number of GP consultations.

[†]Analyses of hospital services also adjusted for specialist physician consultations (yes/*no*).

($P < 0.05$) more likely, respectively, to have had at least one contact with a specialist physician.

Lastly, after adjusting for other determinants of hospital services utilization, active 65- to 79-year-olds were 18% less likely to have had an overnight hospitalization in the previous 12 months (OR = 0.82, $P < 0.05$). Although PA was associated with between 3% and 7% fewer nights in hospital in this age group, this was not statistically significant.

3.1.3. 80 Years and Older Age Group. The results of the regression analyses pertaining to the oldest age group are presented in Table 6. In this age group, no significant associations were found between LTPA and the use of either GP or specialist physician services. Moderately active or active individuals had 7–10% fewer GP consultations over the 12-month study period ($P > 0.05$). While LTPA was not significantly associated with the use of specialist physician services, moderately active and active individuals aged 80 years and older were 10% and 26% more likely, respectively, than their inactive counterparts to have had at least one contact with a specialist physician ($P = 0.068$ and $P = 0.570$, resp.) and active individuals also reported 6% more specialist visits ($P > 0.05$) over the 12-month study period.

The use of hospital services was not significantly associated with LTPA in the 80 years and older age group; however, moderately active and active individuals were 11% and 32% less likely, respectively, to report being hospitalized during

Table 5: The association between LTPA and health services utilization in the 65 to 79 years age group (N = 20,183).

	65 to 79 years age group					
	Unadjusted			Adjusted		
	OR/IRR[a]	(95% C.I.)	Sig	OR/IRR	(95% C.I.)	Sig
GP services						
At least 1 GP contact						
Moderately active	1.13	(0.97–1.32)	0.122	1.13	(0.95–1.34)	0.173
Active	0.84	(0.72–0.97)	0.016	0.99	(0.82–1.21)	0.959
Number of GP consultations[a]						
Moderately active	0.86	(0.81–0.90)	<0.001	0.96	(0.92–1.01)	0.123
Active	0.77	(0.72–0.82)	<0.001	0.96	(0.90–1.01)	0.122
Specialist physician services[*]						
At least 1 specialist contact						
Moderately active	0.96	(0.87–1.06)	0.427	1.03	(0.90–1.18)	0.658
Active	0.93	(0.83–1.04)	0.217	1.13	(0.98–1.31)	0.098
Number of specialist consultations[a]						
Moderately active	0.81	(0.73–0.91)	<0.001	1.02	(0.90–1.15)	0.780
Active	0.80	(0.71–0.90)	<0.001	1.02	(0.91–1.15)	0.709
Hospital services[†]						
Overnight hospitalization						
Moderately active	0.67	(0.57–0.78)	<0.001	0.90	(0.76–1.07)	0.229
Active	0.57	(0.49–0.66)	<0.001	0.82	(0.68–0.98)	0.032
Number of nights in hospital[a]						
Moderately active	0.85	(0.62–1.17)	0.328	0.97	(0.77–1.22)	0.795
Active	0.72	(0.52–1.01)	0.058	0.93	(0.71–1.22)	0.589

[a]The estimate is an incidence rate ratio (IRR).

Note: analyses adjusted for (reference category in italics) the following: age; sex (*male*/female); marital status (married: *yes*/no); education (graduated secondary: *yes*/no); ethnicity (*non-Aboriginal*/Aboriginal); employment status (employed: *no*/yes); household size (*1*, 2, 3, or more people); dwelling size (*<3 bedrooms*, 3 bedrooms, >3 bedrooms); immigration status (*nonimmigrant*, immigrant); injury in previous 12 months (*no*/yes); limitation in ADLs (*no*/yes); smoking status (*never smoked*/former smoker/nonsmoker); exposed to 2nd hand smoke (*no*/yes); alcohol consumption (*<1 drink daily*/at least 1 drink daily); BMI (*<25.0* kg·m^2/25.0–29.9 kg·m^2/≥30 kg·m^2 or greater); time spent walking to work or to run errands (*none*/<1 hour/≥1 hour); cycling to work or to run errands (*no*/yes); typical daily activity level (*usually sitting*/standing or walking/lifting light and/or heavy loads); annual household income (*<$15,000*; $15,000–$29,999; ≥$30,000; missing); province (*ON*, MB, AB, BC, SK, QC, NB, NS, PE, NL, YT/NT/NU); urban-rural classification (*urban*/rural); language (able to speak English and/or French: *yes*/no); has regular family doctor (*yes*/no); self-rated general health (*excellent/very good/good*; fair/poor); self-rated mental health (*excellent/very good/good*; fair/poor); diagnosed with hypertension, cardiovascular disease (including stroke), COPD, asthma, diabetes, cancer, neurological conditions, rheumatological conditions, back problems, gastrointestinal disorders, mood/anxiety disorders, or other chronic conditions (*no*/yes for each); number of chronic conditions (*none*/1 condition/2 conditions/3 conditions/4 or more conditions).

[*]Analyses of specialist services also adjusted for number of GP consultations.

[†]Analyses of hospital services also adjusted for specialist physician consultations (yes/*no*).

the 12-month study period (P = 0.483 and P = 0.087, resp.). Among those reporting a hospitalization, active individuals spent approximately 20% more nights in hospital, although this was also not statistically significant (P = 0.401).

While not the primary variable of interest in this study, significant associations were found between typical daily activity and several of the dependent variables such that a brief presentation of these findings is warranted (see Table 7). Respondents were asked to choose the best description of their usual daily activities or work habits outside of their LTPA (sitting; mostly standing or walking; mostly lifting light or heavy loads) and, across all age groups, higher levels of usual activity were associated with lower health services utilization. In the 50- to 64-year-old age group, those reporting lifting light or heavy loads had significantly fewer GP consultations (IRR = 0.91; $P < 0.05$) and were 15% less likely to use specialist physician services ($P < 0.05$) compared to those reporting sitting as their typical daily activity. Among 65- to 79-year-olds, respondents reporting the highest level of usual activity were 23% significantly less likely to have contact with a GP physician ($P < 0.05$), had 13% fewer GP ($P < 0.001$) and 14% fewer specialist physician consultations ($P = 0.065$), were 32% less likely to be hospitalized overnight ($P < 0.001$), and spent 42% fewer nights in hospital than their sitting counterparts ($P < 0.05$). In the oldest age group, standing/walking and lifting light or heavy loads were associated with lower levels of GP and specialist physician service utilization compared to those whose typical activity

Table 6: The association between LTPA and health services utilization in the 80 years and older age group (N = 6,555).

	80 years and older age group					
	Unadjusted			Adjusted*		
	OR/IRR[a]	(95% C.I.)	Sig	OR/IRR	(95% C.I.)	Sig
GP services						
At least 1 GP contact						
Moderately active	0.74	(0.55–1.01)	0.058	0.77	(0.52–1.15)	0.199
Active	0.84	(0.60–1.19)	0.324	1.26	(0.78–2.03)	0.340
Number of GP consultations[a]						
Moderately active	0.82	(0.74–0.92)	<0.001	0.93	(0.83–1.04)	0.225
Active	0.72	(0.65–0.81)	<0.001	0.90	(0.79–1.02)	0.113
Specialist physician services*						
At least 1 specialist contact						
Moderately active	1.12	(0.92–1.37)	0.263	1.26	(0.98–1.61)	0.068
Active	0.95	(0.74–1.21)	0.660	1.10	(0.80–1.50)	0.570
Number of specialist consultations[a]						
Moderately active	0.91	(0.69–1.20)	0.516	0.98	(0.80–1.21)	0.865
Active	0.91	(0.68–1.21)	0.506	1.06	(0.81–1.40)	0.661
Hospital services†						
Overnight hospitalization						
Moderately active	0.69	(0.53–0.89)	0.004	0.89	(0.65–1.22)	0.483
Active	0.48	(0.34–0.67)	<0.001	0.68	(0.43–1.06)	0.087
Number of nights in hospital[a]						
Moderately active	0.77	(0.55–1.08)	0.132	0.99	(0.69–1.43)	0.966
Active	0.72	(0.48–1.09)	0.119	1.19	(0.79–1.79)	0.401

[a]The estimate is an incidence rate ratio (IRR).

Note: analyses adjusted for the following (reference category in italics): age; sex (*male*/female); marital status (married: *yes*/no); education (graduated secondary: *yes*/no); ethnicity (*non-Aboriginal*/Aboriginal); employment status (employed: *no*/yes); household size (*1*, 2, 3, or more people); dwelling size (*<3 bedrooms*, 3 bedrooms, >3 bedrooms); immigration status (*nonimmigrant*, immigrant); injury in previous 12 months (*no*/yes); limitation in ADLs (*no*/yes); smoking status (*never smoked*/former smoker/nonsmoker); exposed to 2nd hand smoke (*no*/yes); alcohol consumption (*<1 drink daily*/at least 1 drink daily); BMI (*<25.0* kg·m^2/25.0–29.9 kg·m^2/≥30 kg·m^2 or greater); time spent walking to work or to run errands (*none*/<1 hour/≥1 hour); cycling to work or to run errands (*no*/yes); typical daily activity level (*usually sitting*/standing or walking/lifting light and/or heavy loads); annual household income (*<$15,000*; $15,000–$29,999; ≥$30,000; missing); province (*ON*, MB, AB, BC, SK, QC, NB, NS, PE, NL, YT/NT/NU); urban-rural classification (*urban*/rural); language (able to speak English and/or French: *yes*/no); has regular family doctor (*yes*/no); self-rated general health (*excellent/very good/good*; fair/poor); self-rated mental health (*excellent/very good/good*; fair/poor); diagnosed with hypertension, cardiovascular disease (including stroke), COPD, asthma, diabetes, cancer, neurological conditions, rheumatological conditions, back problems, gastrointestinal disorders, mood/anxiety disorders, or other chronic conditions (*no*/yes for each); number of chronic conditions (*none*/1 condition/2 conditions/3 conditions/4 or more conditions).

*Analyses of specialist services also adjusted for number of GP consultations.

†Analyses of hospital services also adjusted for specialist physician consultations (yes/*no*).

was sitting (IRR = 0.66–0.89; $P < 0.05$). Lifting light or heavy loads was also associated with 48% fewer nights in hospital in this age group ($P < 0.001$).

4. Conclusion

The primary purpose of this study was to examine relationships between leisure time PA and health services utilization in a nationally (Canadian) representative sample of community-dwelling older adults. Rather than classifying all respondents as one homogeneous group, these relationships were explored separately for 3 age groups: 50 to 64 years, 65 to 79 years, and 80 years and older in order to add precision to the existing knowledge base [15]. The descriptive analysis showed that the use of health services generally increased with increasing age, with the exception of consultations with specialist physicians. Between 10% and 22% of respondents reported that they did not consult with a GP physician in the 12-month period, somewhat of a concerning finding from a health perspective given that it may mean that older adults are going without preventative health care or are having difficulty accessing necessary care. An alternative explanation may be that these individuals received health services from providers other than general practitioners, such as nurse practitioners, naturopathic physicians, chiropractors, and physiotherapists; however, this was not assessed in the present study.

The multivariate analyses showed that, in general, higher LTPA was associated with lower health services utilization; however, few of the associations were statistically significant.

Table 7: The association between differing levels of typical daily activity[a] and health services utilization, stratified by age.

	50 to 64 years n = 29,914			65 to 79 years n = 20,183			80 years and older n = 6,555		
	OR/IRR[b]	95% CI	P	OR/IRR[b]	95% CI	P	OR/IRR[b]	95% CI	P
General physician services									
At least 1 contact with a GP									
Standing or walking	1.13	(0.96–1.32)	0.143	1.19	(0.96–1.47)	0.107	0.73	(0.50–1.07)	0.104
Lifting light/heavy loads	0.90	(0.76–1.06)	0.221	0.77	(0.61–0.98)	0.030	0.77	(0.46–1.28)	0.312
Number of GP consultations[b]									
Standing or walking	0.97	(0.92–1.02)	0.298	0.97	(0.92–1.02)	0.239	0.89	(0.81–0.99)	0.027
Lifting light/heavy loads	0.91	(0.86–0.97)	0.002	0.87	(0.82–0.93)	<0.001	0.84	(0.73–0.95)	0.006
Specialist physician services									
At least 1 contact with a specialist									
Standing or walking	0.95	(0.85–1.06)	0.366	0.88	(0.77–1.00)	0.048	0.85	(0.68–1.07)	0.169
Lifting light/heavy loads	0.85	(0.75–0.97)	0.020	0.86	(0.74–1.01)	0.065	0.72	(0.52–0.99)	0.041
Number of specialist consultations[b]									
Standing or walking	0.80	(0.70–0.93)	0.002	0.86	(0.75–0.98)	0.023	0.76	(0.63–0.92)	0.005
Lifting light/heavy loads	0.74	(0.64–0.86)	<0.001	0.82	(0.71–0.95)	0.006	0.66	(0.50–0.88)	0.005
Hospital services									
Overnight hospitalization									
Standing or walking	0.93	(0.77–1.12)	0.431	0.85	(0.72–1.01)	0.060	0.80	(0.62–1.03)	0.081
Lifting light/heavy loads	0.88	(0.70–1.09)	0.243	0.68	(0.56–0.84)	<0.001	0.92	(0.64–1.34)	0.678
Number of nights in hospital[b]									
Standing or walking	0.78	(0.64–0.94)	0.008	0.84	(0.68–1.03)	0.095	0.78	(0.59–1.02)	0.072
Lifting light/heavy loads	0.85	(0.67–1.09)	0.204	0.58	(0.45–0.76)	<0.001	0.52	(0.36–0.76)	0.001

[a]Typical daily activity is a 3-level categorical variable describing respondents' usual level of daily activity outside of LTPA. The reference group (not shown in table) is "usually sitting."

[b] The estimate is an incidence rate ratio (IRR).

Note: adjusted for (reference category in italics) the following: age; sex (*male*/female); marital status (married: *yes*/no); education (graduated secondary: *yes*/no); ethnicity (*non-Aboriginal*/Aboriginal); employment status (employed: *no*/yes); household size (*1*, 2, 3, or more people); dwelling size *(<3 bedrooms*, 3 bedrooms, >3 bedrooms); immigration status (*nonimmigrant*, immigrant); injury in previous 12 months (*no*/yes); limitation in ADLs (*no*/yes); smoking status (*never smoked*/former smoker/nonsmoker); exposed to 2nd hand smoke (*no*/yes); alcohol consumption (*<1 drink daily*/at least 1 drink daily); BMI (*<25.0* kg·m^2/25.0–29.9 kg·m^2/≥30 kg·m^2 or greater); time spent walking to work or to run errands (*none*/<1 hour/≥1 hour); cycling to work or to run errands (*no*/yes); typical daily activity level (*usually sitting*/standing or walking/lifting light and/or heavy loads); annual household income (*<$15,000*; $15,000–$29,999; ≥$30,000; missing); province (*ON*, MB, AB, BC, SK, QC, Other); urban-rural classification (*urban*/rural); language (able to speak English and/or French: *yes*/no); has regular family doctor (*yes*/no); self-rated general health (*excellent/very good/good*; fair/poor); self-rated mental health (*excellent/very good/good*; fair/poor); diagnosed with hypertension, cardiovascular disease (including stroke), COPD, asthma, diabetes, cancer, neurological conditions, rheumatological conditions, back problems, gastrointestinal disorders, mood/anxiety disorders, or other chronic conditions (*no*/yes for each); number of chronic conditions (*none*/1 condition/2 conditions/3 conditions/4 or more conditions); number of GP consultations.

Leisure time PA was significantly associated with lower use of GP physician services in the 50 to 64 years age group, with active individuals 27% less likely to have contact with a GP and reporting 8% fewer GP consultations than their inactive counterparts in the 12-month study period. These findings are consistent with those of Woolcott et al. [24], as well as Wang et al. [39], who found that regular PA was associated with significantly lower outpatient health care costs in a group of Medicare retirees. Similarly, Mitchell et al. [40] also found physician visits to be inversely associated with physical fitness among 6,679 men aged 20–79 years. It is, however, important to note that the findings in this area are somewhat equivocal, with several studies reporting no significant association between LTPA and physician visits [27, 41, 42].

A significant association was also evident between LTPA and hospital services in the 65 to 79 years age group, where active individuals were 8% less likely to be hospitalized than their inactive counterparts. This partially supports the findings of recent studies by Woolcott et al. [24] and Sari [26] which found that LTPA was associated with a decreased likelihood of hospitalization and fewer nights spent in hospital among Canadians aged 65 years and older. While LTPA was mostly associated with fewer nights spent in hospital in the present study, these associations were not statistically significant. In the oldest age group, active respondents were actually more likely to report more nights in hospital. One explanation for the different findings may be related to the stratification of the sample of the present study. The studies by Woolcott et al. [24] and Sari [26] examined CCHS respondents aged 65 years and older as a single study population. There is considerable heterogeneity within the older adult population relative to PA, health, and health services utilization and it is possible that the stratification

of the sample in the present study revealed differences in health services utilization that were obscured in studies which examined the population as a whole [15].

Although not statistically significant, the results pertaining to the use of specialist services revealed an interesting pattern. In the two oldest age groups, moderately active and active individuals were more likely than their inactive counterparts to have consulted a specialist in the previous 12 months. One possible explanation may be that moderately active and active older adults may be more health conscious and/or more health "literate" and therefore may seek referrals to specialists more frequently than inactive older adults [43]. The data related to specialist physician visits in the CCHS preclude an in-depth analysis of the physician specialty or the reasons underlying visits to specialists, both of which would provide important insights into the utilization of specialist physician services. However, despite its importance from a policy perspective, very few studies have examined the relationship of PA and specialist physician visits separate from visits to other physicians.

The lack of agreement between studies of PA and health services utilization may be due, in part, to considerable variation in sample populations, study design, and methods. There is no single "gold standard" measure of health services utilization and differences between studies in its operationalization make it difficult to form generalizations based on the available literature. Likewise, beyond the use of self-reported PA measures, there is very little consistency between studies in how PA is assessed. While most studies examining PA and health services utilization in older adults have used populations aged 65 years and older, the present study used a sample aged 50 years and older. There is significant heterogeneity in health status, PA participation, and health services utilization in the older adult population [15, 16, 36]. Also, there are a number of significant life transitions that typically occur after the age of 50, such as retirement and bereavement, which may have implications for health and health services utilization. Stratifying the data into smaller age groups coinciding with key transition periods and adjusting for age within each age group allows for a more precise analysis and comprehensive examination of the association between LTPA and health services utilization in this diverse population. For example, 50 to 65 years is the age range when many chronic conditions emerge and are diagnosed, hence the increased association with physician visits in this age group. In middle age group (65 to 79 years), chronic conditions may be worsening, resulting in stronger associations with hospitalizations. In both instances, LTPA may play an important role by either delaying the clinical manifestation of certain conditions or slowing progression of the disease process, thereby helping to delay or prevent this type of utilization in younger older adults.

Another notable difference between this analysis and previous studies was the inclusion of a wide-ranging set of control variables. A number of factors influence one's decision to seek medical care and the majority of earlier studies are lacking in their ability to account for other determinants of health services utilization, be they demographic and socioeconomic factors, physical and mental health status and medical comorbidities, or personal health practices such as smoking and drinking [26, 27, 37]. It is likely that physical activity affects health care utilization through its relationship with overall health [27]. By including a comprehensive set of health-related control we were also able to account for variations in health that may affect both the level of physical activity and healthcare utilization [26, 27, 37].

While LTPA was the primary focus of this study, respondents' typical daily activity outside of LTPA was also examined and appeared to be a stronger predictor of all types of health services utilization, particularly in the two oldest age groups. Even in the youngest age group, typical daily activity was significantly associated with the use of specialist services, where LTPA was not. One possible explanation may be that the typical daily activity variable may provide an indication of sedentary behavior, which is also associated with the development and chronic health conditions and poorer health status, independent of LTPA [44]. Among younger older adults still in the workforce, the amount of PA accrued during a typical day may exceed that accrued through LTPA due to the number of hours spent working; therefore this type of PA may be a more salient predictor of health services utilization. Another explanation may have to do with how respondents classified their own PA. Older adults typically participate in activities such as housework, gardening, and caregiving more frequently than other types of LTPA [45, 46]. Given that these types of PA were not specified in the CCHS instrument, respondents may have considered them as part of their usual daily activities. This highlights the importance of implementing measures of PA that are appropriate for older adults, given the types of PA typically reported in this population. It is possible that a more appropriate measure of LTPA may have revealed more significant associations with health services utilization. Lastly, among respondents aged 80 years and older, typical daily PA may be reflective of greater mobility and health status and, thus, be a stronger predictor of health services utilization.

Prior research in the area of PA and health services utilization has predominantly been focused on individuals in the workplace. This study is among a small few to examine the relationship between PA and health services utilization in community-dwelling older Canadians. Furthermore, the focus on both LTPA and typical daily PA is unique and provides new insights into the relationship between PA and health services utilization in the older adult population. Nonetheless, this study has certain limitations that should be considered when interpreting the results. The cross-sectional nature of the survey data precludes the inference of causal relationships and one cannot discount the possibility that reverse causality between the outcome measures and one or more independent variables is present. Furthermore, given the self-reported nature of the data, bias due to inaccurate recall or social desirability remains a possibility, particularly in the PA and health services data. Previous studies have shown that older adults tend to overreport contacts with GP physicians and underreport contacts with medical specialists, while recall of events such as hospitalizations appears to be more accurate, perhaps because these events are more highly

salient and easily remembered [47, 48]. Likewise, there are issues with the use of self-reported measures of PA in an older population including vision and hearing impairments or disturbances to cognition and short- or long-term memory [49]. Additional problems may include the ability to accurately report activity intensity, because perceptions of what is "hard" activity or "light" activity depend on the tolerance and fitness level of the individual, both of which decline as a person ages [49].

Limitations owing to the CCHS instrument itself, while beyond our control, should also be pointed out. First, the discrepancy in recall periods between the health services utilization and LTPA variables may have made it more difficult to identify significant relationships; however, it would be considerably more difficult to accurately recall PA behaviors over a 12-month period compared to a lower frequency event such as health services utilization over the same period [27]. Furthermore, the measurement of LTPA in the CCHS may underestimate older adults' LTPA, particularly in the oldest age group, for at least two reasons: (1) the instrument does not specifically include more prevalent leisure time activities of older adults, such as housekeeping or caregiving and (2) the questionnaire may not be sensitive enough to detect the typically light and brief activity of elderly people [20, 49].

The above limitations notwithstanding, this study provides a significant contribution to a growing body of evidence suggesting that PA leads to lower health services utilization in community-dwelling older Canadians. Older adults are a very diverse group and this heterogeneity must be considered when examining health services utilization in this population. Although many of the estimates produced in the analyses were not statistically significant, they may have considerable relevance from a clinical perspective. For example, the results showed that moderately active and active respondents in the two oldest age groups were more likely to have at least 1 contact with a specialist and active individuals in the oldest age group appeared to have higher overall utilization of specialist physicians than their inactive or moderately active counterparts. Given that costs associated with specialist physician services are considerably higher than those associated with GP physician services, this finding warrants further exploration. Further studies of the patterns of health services utilization among sedentary, inactive, and active older adults would better clarify the potential role of PA as a strategy to decrease health services utilization and costs. *In addition, these findings suggest that both general and specialist physicians should be engaged in discussions related to physical activity given that older adults seek care from both groups of health professionals.*

In summary, it is possible that interventions aimed at increasing LTPA in this population may result in tangible reductions in health services utilization. The results also suggest that encouraging sedentary and inactive older adults, particularly those over age 65, to maintain or increase their overall daily activity, perhaps simply by reducing time spent in sedentary behaviors, may have an even greater impact on reducing the demand for health services. Given the wide variation in the literature with regard to study populations and methodologies, additional studies, with common outcome measures, appropriate and robust assessments of PA, and sedentary behavior, and adequate controls for confounders, are needed to obtain credible and accurate estimates of the effects of PA. Moreover, prospective longitudinal studies into the causal relationship between PA and health services utilization would provide important information on the potential impact would provide important insights about the potential impact of population-based strategies to increase PA participation among older adults on the health care system.

Disclaimer

The views expressed in this paper do not necessarily represent the views of CRDCN or those of its partners.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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Research Article

Falls Reduction and Exercise Training in an Assisted Living Population

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Multicomponent exercise programs are currently an efficacious fall prevention strategy among community dwelling older adults although research documents differential falls susceptibility among frail older adults. This study aimed to examine the association between the Boston FICSIT (Frailty and Injuries: Cooperative Studies of Intervention Techniques) exercise program (the original exercise program to demonstrate that nursing home residents can increase strength) and falls incidents in an assisted living community. A descriptive cross-sectional study matched exercise charts for frequency and duration of training with number of reported fall incidents. Among 39 participants, 33% ($n = 13$) reported a fall incident. Adults without a fall history reported more time in aerobic (26.30 versus 20.00, P value $= 0.71$) and strength (1.50 versus 0.50, P value $= 0.01$) training sessions compared to those with a fall history. Multivariate models adjusting for covariates illustrated a significant protective association between strength training and fall incidents (OR $= 0.25$; 95% CI $= 0.07, 0.85$). In this cross-sectional study, this progressive resistance exercise training program into an assisted living population was associated with a decrease in the number of fall incidents.

1. Introduction

In the US, 30% of older adults experience at least one fall annually, with a particularly higher rate (50%) over the age of 80 [1]. Falls not only are the leading cause of injury death, but also are the most common cause of nonfatal injuries and lead to chronic pain and disability [2]. An estimated $30 billion dollars was spent in 2010 on inpatient hospitalizations and outpatient medical costs related to falls [3]. Falls create an enormous economic burden and effective falls prevention will reduce health care costs and increase quality of life in older age [4].

The US Preventive Services Task Force states that multifactorial risk assessments offer a small benefit for falls prevention in community dwelling (CD) older adults [5]. Some risk factors can be modified using exercise (e.g., impaired balance and gait), whereas others require different intervention approaches (e.g., poor vision) [6]. On the other hand, exercise training programs for CD adults have considerable benefit and can be used as a stand-alone falls prevention intervention or as a component of a multifaceted program. Prior studies have established the fact that exercise interventions for falls reduction and injury prevention are effective in CD older adults [5–11]. However, high interindividual variability and differential falls susceptibility in CD versus frail older adults suggest falls prevention programs designed for CD older adults may not be translatable to more frail older adults in assisted living (AL) and nursing homes. AL communities are the fastest-growing noninstitutional long-term care alternative in the US for older adults [12]. As a result, AL communities are an extraordinarily diverse shelter and care alternative, and very frail older persons with serious chronic health conditions can be found in this setting [12]. Limited research has examined associations between exercise programs and falls among AL populations [13].

This exercise program was designed by exercise physiologists in the 1980s and 1990s from Tufts University School of Nutrition and Center for Healthy Aging (i.e., William J. Evans, Ph.D., and Miriam E. Nelson, Ph.D.). The aim of the program was to reverse bone loss and improve energy and balance among older adults by progressive resistance exercise training [14]. This exercise program laid the foundation for current evidence-based CD programs. Moreover, it was found to be efficacious by a randomized controlled trial conducted by Fiatarone and colleagues using data from the Boston Frailty and Injuries: Cooperative Studies of Intervention Techniques (FICSIT) study [15]. Results from the trial demonstrated that it was both feasible and effective in counteracting muscle weakness and physical frailty among nursing home residents [14, 15]. Progressive resistance exercise three days a week for ten weeks significantly improved the results of all muscle-strength tests. Specifically, among those who participated in exercise training, gait velocity increased by 11.8% and overall muscle strength increased by 111.3%, compared to nonexercisers [15]. While the exercise program was successful among frail adults in a nursing home, it is not clear whether this program would be efficacious among AL populations to reduce falls.

The goal of the present study was to evaluate the association of the aerobic and strength training exercise program, adopted from Fiatarone et al., to reduce falls incidents and falls-related injuries in an AL population [15].

2. Materials and Methods

Participants for this five-year period prevalence cross-sectional study (2007–2011) were ascertained from one community in a privately owned, for-profit senior housing company that provides independent living, assisted living, and memory care services. Inclusion criteria for participation in the exercise program included (1) being current community resident, (2) attending a meeting with the community activity director, and (3) having signed form submitted by participant's physician. The Columbia University Medical Center Institutional Review Board approved this retrospective study.

2.1. Exercise Intervention. Dr. Miriam E. Nelson, the Exercise Physiologist from Tufts, came to the AL communities in the late 1990s and helped to translate the Boston FICSIT program into several communities [15]. Exercise program guidelines advised AL residents to incorporate aerobic and strength training into their regular exercise routine three times a week using equipment available in the community's fitness center. Strength training was performed on Keiser Air Resistance Equipment, with supervision, and included shoulder press, seated row, leg extension, leg curl, and leg press machines. Aerobic training was performed on NuStep machines or treadmills. Residents also had the option of participating in chair exercise classes held six days a week for one hour; these sessions included stretching, hand weights, and resistance bands. Activity directors supervising the program assisted participants in the fitness center and followed up with those who failed to attend regular sessions.

The staff member on duty in the fitness center set up the equipment and recorded mode, frequency, and duration of each activity in participants' individual exercise chart. For strength training, staff documented exercise, machine resistance, and number of repetitions and sets. For aerobic training, time, speed, and resistance were recorded. The exercise chart remained with the participant throughout the program.

2.2. Falls Assessment. A fall was defined as unintentionally coming to rest on the ground, floor, or any other lower level [16]. Staff recorded the fall incident using a standard incident report form. Additional information collected about the fall incident included date, injury, location, cause (as stated by participant), reason for fall, and history of falls. Fall incident report data was merged with a participants' other study information.

2.3. Exercise Dose and Participation Assessment. Two primary measures of exercise were retrospectively obtained from exercise charts: aerobic training in minutes and number of strength training sessions. From these chart values, three variables were calculated: years of participation, number of aerobic and strength sessions attended each week, and minutes of participation in each aerobic session.

2.4. Statistical Analysis. Statistical analyses were performed using SAS Version 9.2. Descriptive analyses were used to report characteristics of the study population by falls history, including age, gender, and participation in the exercise program. Differences in participation history between those with a fall history and those without it were tested using t-tests. Logistic regression models were designed to assess the association between volume of exercise participation and falls incidents, adjusting for gender and age.

3. Results

In the 39 individuals in this analysis, a total of 13 (33.3%) reported a fall incident during the five-year period. The mean age in years was 87.4 at the beginning of the study; 74.4% (N = 29) were female. The mean participation in the exercise program was 2.2 years, with mean aerobic and strength training at 197.7 minutes and 136.1 sessions, respectively. Among those with a fall record, a total of 60 incidents were reported; of those, half reported at least two or more falls. Most common reported reason for fall incident was loss of balance.

Results comparing study population characteristics according to fall status are shown in Table 1. Negative associations for fall incidents were recorded with total exercise program participation, aerobic training, and strength training. Weekly descriptors of training illustrated similar results. Those with no reported fall incidents documented more time in aerobic training minutes per week (26.30 versus 20.00, P value = 0.71) and strength training sessions per week (1.50 versus 0.50, P value = 0.01) compared to those with a reported fall incident.

Table 1: Exercise participation in relation to fall status.

Characteristic	Fall history ($n = 13$)		No fall history ($n = 26$)		P for trend*
	Mean ± SD	Range	Mean ± SD	Range	
Fitness program participation, days	588.8 ± 648.4	1–1,834	886.7 ± 977.2	1–2,954	0.1389
Aerobic training					
Total aerobic training sessions	130.7 ± 190.6	1–567	231.2 ± 267.4	0–859	0.2201
Aerobic training minutes per week	20.0 ± 15.6	0–52	26.3 ± 14.4	0–49	0.7101
Strength training					
Total strength training sessions	81.5 ± 158.6	0–513	163.4 ± 248.5	0–831	0.1065
Strength training sessions per week	0.5 ± 0.2	0–2	1.5 ± 1.6	0–7	0.0054

*Results from t-test comparing means for fall history and no fall history groups.

Dose-dependent associations for fall incidents were seen with participation in the exercise program (Table 2). In adjusted models, aerobic and strength training were associated with decreased odds of a fall incident. Specifically, those who recorded a greater number of total strength training sessions were significantly less likely to experience a fall incident (OR = 0.25; 95% CI = 0.07, 0.85) than those with fewer total sessions.

Table 2: Multivariate logistic regression model of factors associated with fall history in an assisted living population.

Characteristic	Unadjusted OR(95% CI)	Adjusted OR* (95% CI)
Total program participation	1.00 (0.99, 1.00)	0.99 (0.99, 1.00)
Aerobic training	0.97 (0.93, 1.02)	0.97 (0.92, 1.03)
Strength training	0.42 (0.18, 0.96)	0.25 (0.07, 0.85)

*Adjusted for age and gender; $N = 39$.

4. Discussion

This study reports findings from a cross-sectional study investigating the association between the Boston FICSIT and fall incidents among older adults in one AL community. Our findings report a protective association between strength training and fall incidents; the odds of a fall incident among those who logged more time strength training were less compared to those who logged less time. More specifically, individuals with a greater number of strength training sessions per week had 75% reduced odds of a fall incident than those with fewer sessions.

Analysis of the Boston FICSIT cohort data by Fiatarone et al. reported this exercise training program significantly improved the results of all muscle-strength tests among exercise participants compared to controls [15]. Among those who participated in exercise training, gait velocity increased by 11.8% and overall muscle strength increased by 111.3%, compared to nonexercisers [15]. The present study attempts to investigate if this same exercise program is associated with falls reduction in the AL population. This study appears to provide additional evidence that progressive resistance exercise training, as first reported by Boston FICSIT exercise training study, is associated with reducing fall incidents in another frail older adult setting, the AL population [15].

Results of this study suggest that older adults who spent less time in the exercise program may be more susceptible to fall incidents than those with greater time spent. Our analysis is limited by the cross-sectional study design; caution in the interpretation of the observed associations must be taken into account. A second limitation was the inability to control for baseline health among participants and lack of screening for additional activity outside the prescribed exercise program. Third, incident reports, while standardized and structured, were used to enumerate the dependent variables and are likely to capture only falls requiring assistance from the facility staff. Therefore, fall incidents may be underreported in this population. Finally, there is no comparison group; this study assessed the association among only those who participated in the exercise program. Therefore, we do not have information about those who did not participate in the program and their fall incidents.

The findings of this study have important implications for AL populations and highlight the need for future research to identify specific exercise programs, specifically focusing on strength training protocols, to garner the best outcomes among this population. Future research should include the following topics: the amount of time spent in strength training to effectively reduce falls, the types of strength training exercises that are the most beneficial in reducing falls, and inclusion of both aerobic and strength training. This could facilitate interventions aimed at reducing falls incidents among vulnerable older adult populations.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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Research Article

Which Part of a Short, Global Risk Assessment, the Risk Instrument for Screening in the Community, Predicts Adverse Healthcare Outcomes?

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The Risk Instrument for Screening in the Community (RISC) is a short, global risk assessment to identify community-dwelling older adults' one-year risk of institutionalisation, hospitalisation, and death. We investigated the contribution that the three components of the RISC (*concern*, its *severity*, and the ability of the *caregiver network* to manage concern) make to the accuracy of the instrument, across its three domains (mental state, activities of daily living (ADL), and medical state), by comparing their accuracy to other assessment instruments in the prospective Community Assessment of Risk and Treatment Strategies study. RISC scores were available for 782 patients. Across all three domains each subtest more accurately predicted institutionalisation compared to hospitalisation or death. The *caregiver network's* ability to manage ADL more accurately predicted institutionalisation (AUC 0.68) compared to hospitalisation (AUC 0.57, $P = 0.01$) or death (AUC 0.59, $P = 0.046$), comparing favourably with the Barthel Index (AUC 0.67). The *severity* of ADL (AUC 0.63), medical state (AUC 0.62), Clinical Frailty Scale (AUC 0.67), and Charlson Comorbidity Index (AUC 0.66) scores had similar accuracy in predicting mortality. Risk of hospitalisation was difficult to predict. Thus, each component, and particularly the *caregiver network*, had reasonable accuracy in predicting institutionalisation. No subtest or assessment instrument accurately predicted risk of hospitalisation.

1. Introduction

Population ageing [1] is associated with rising numbers of frail and functionally impaired community-dwelling older adults [2]. As time is limited in clinical practice, short risk prediction instruments are useful in identifying frailty [3] and quantifying the potential for adverse healthcare outcomes in this population [4]. Traditionally, healthcare practitioners have used demographic details and a battery of cognitive and functional tests in an attempt to predict risk [5], triage

patients and rationalize the provision of limited healthcare resources [4]. Although multiple measures of frailty exist; few have been tested for reliability or validity [6].

More recently, instruments to identify specific adverse outcomes have been developed. These include tools to measure the likelihood of hospitalisation [7], readmission [8], institutionalisation [9], and mortality [10], often within a defined period of time. Few have targeted risk of institutionalisation, an important marker of healthcare utilisation [11]. Institutionalisation in turn is associated with other adverse outcomes such as risk of death [12]. Identifying risk is important as it singles out those who may benefit from more intensive, targeted interventions [4]. Few instruments are available in the community to screen large numbers of patients quickly and in their own environment for risk of functional decline, while simultaneously measuring risk of hospitalisation, institutionalisation, and death.

The Risk Instrument for Screening in the Community (RISC) is a new, short [13, 14], reliable [15], and valid [16] global subjective assessment of risk, designed for use by community healthcare workers. It was developed as part of Irelands' European Innovation Project on Active and Healthy Ageing three-star reference site the COLLaboration on AGEing (COLLAGE) [17]; see the Community Assessment of Risk and Treatment Strategies (CARTS) study at http://www.collage-ireland.eu/. The RISC identifies the presence and severity of concern in three domains (mental state, ADL, and medical state) [14]. Based upon the ability of an individuals' caregiver network to manage the patients' care needs, the one-year risk of three adverse outcomes, hospitalisation, institutionalisation, and death, is scored according to the magnitude and likelihood of an event, from 1 (minimal and rare) to 5 (extreme and certain). Short, often single, question screens similar to this have been used successfully in other studies. These include the "surprise question" [18], an independent predictor of one-year mortality, validated in different patient groupings [19], and the "Yale-Brown" [20] and "down-hearted and blue?" [21] single depression questions. Similarly, a single question "is the patient frail?" correlates with the Clinical Frailty Scale [13].

The contribution that each part of the RISC contributes to the overall predictive validity of the tool is unknown. Given this, we sought to investigate which part of the RISC contributes to the sensitivity and specificity of the instrument and how the components of the RISC compare to a traditional battery of screening instruments and to identify the components of the RISC which predict each of the three adverse healthcare outcomes under consideration.

2. Materials and Methods

2.1. The Risk Instrument for Screening in the Community (RISC). The RISC collects demographic data and scores three domains: mental state, ADL (functional state), and medical state. Each has three components, called steps. The first step identifies whether there is a *concern* about this domain and is scored dichotomously (Yes/No). If there is no concern, the rater moves on to the next domain. If there is concern, the rater assesses the *severity* of the *concern* on a scale from one to three (mild, moderate, or severe). The ability of the *caregiver network* to manage the concern, within each domain, is then scored using a five-point Likert scale from 1 to 5 (1: can manage; 2: carer strain; 3: some gaps; 4: cannot manage; 5: absent/liability). The *caregiver network* includes the formal and informal resources and services that are available to the person. Finally, the *severity* of concern and the ability of the *caregiver network* are taken into account when completing the three global risk scores *of institutionalisation*, *hospitalisation,* and *death*, within one-year of assessment. These are also scored on a Likert scale from 1 (minimal/rare) to 5 (extremely likely/certain). In order to analyze the data, patients were subsequently divided into minimum (global risk score of 1 or 2) and maximum (global risk score of 3, 4, or 5) risk of each adverse healthcare outcome [14].

2.2. Patients. This study includes a secondary analysis of 803 patients included in the CARTS study. All patients were community-dwelling older adults, aged over 65 years. Only those recently reviewed and under long-term follow-up by their public health nurse (PHN) were included. The baseline characteristics of these patients have been published previously [13]. In summary, the median age of patients was 80 years (interquartile range 10) and 64% were females. Additional demographics and the results of a selection of cognitive and functional assessments were also available. The median Barthel Index (BI) score was 18 (+/−6), abbreviated mental test score (AMTS) [22] was ten (+/− <1), Charlson Comorbidity Index [23] score was one (+/− two), and the Clinical Frailty Scale (CFS) [24] was five (+/− two).

2.3. Data Collection and Sampling. The collection of data in the CARTS study has been described previously [13]. In summary, all PHN sectors in County Cork were invited to participate. Two, Ballincollig and Bishopstown and Mahon and Ballintemple, were the first respondents and were sampled based on the nonprobability method of convenience sampling using a quota method. All PHNs ($n = 15$) from these centres were trained and certified in scoring the RISC [15, 25]. Scoring was based on the PHNs knowledge of the patients. Each PHN only scored patients directly under their care. Demographic data were recorded from PHN records by a clinician blinded to the RISC scores. One year follow-up data on hospitalisation and death were obtained from the hospital in-patient enquiry system of all hospitals in Cork. Follow-up data on institutionalisation were obtained from the Cork Local Placement Forum. Ethical approval for the CARTS study was granted by the Clinical Research Ethics Committee of the Cork Teaching Hospitals and adhered to the tenants of Declaration of Helsinki.

2.4. Statistical Analysis. Data were analysed using SPSS version 20.0. Accuracy of components was determined from the AUC, calculated from receiver operating characteristic (ROC) curves. ROC scores above 0.50 indicated that the component had better predictive power than by chance alone. Nonoverlapping 95% confidence intervals (CI) suggested statistically significant differences between components.

Cronbach's alpha coefficient (α) and the intraclass correlation coefficient (ICC) measured internal consistency.

3. Results

One-year outcomes comparing the RISC to the CFS have been presented previously [16]. In summary, RISC scores were available for 782 with 21 missing as patients were lost to follow-up. At baseline, 88%, 64%, and 79% were scored as minimum risk for institutionalisation, hospitalisation, and death, respectively. At one year, the incidence of the three adverse outcomes were 10.2% for institutionalisation, 17.7% for hospitalisation (at least one), and 15.6% for death. The accuracy of the global risk score to predict the outcomes was higher for risk of institutionalisation (AUC of 0.70) and death (AUC of 0.70) than hospitalisation (AUC of 0.61). Patients scored as maximum risk of institutionalisation had a 31.3% incidence of admission to long-term care compared with 7.1% for patients scored as minimum risk. Those scoring maximum RISC had a 25.4% and 33.5% incidence of hospitalisation and death compared to 13.2% and 10.8% for minimum risk patients, respectively.

Internal consistency between the three domains of the RISC, assessed with Cronbach's alpha, was high ($\alpha = 0.72$) with scores above 0.7 indicating a high degree of reliability. The ICC, using one-way random effect model, was 0.68 (95% CI 0.61–0.70, $P < 0.001$), indicating a relatively high degree of agreement between the three domains of the RISC.

3.1. Components (Steps) of the RISC. Each step was examined to determine how accurately they predicted one-year outcomes. For the first step, assessing whether a *concern* was present or not, the AUC for predicting institutionalisation was 0.62 (95% CI: 0.55–0.69) for the mental state domain compared with 0.60 (95% CI: 0.54–0.66) for ADLs and 0.54 (95% CI: 0.48–0.61) for the medical state. *Concern* (Yes/No) on its own was a poor predictor of both hospitalisation and death, with all AUC values being less than 0.60 (see Table 1). The *severity* (mild, moderate, or severe) of each domain more accurately predicted institutionalisation compared to hospitalisation or death. The *severity* score of each domain was least accurate in predicting hospitalisation. The ability of the *caregiver network*, irrespective of domain assessed, more accurately predicted institutionalisation compared to the other adverse outcomes. The *caregiver networks*' ability to manage concern for ADL was significantly more accurate in predicting one-year risk of institutionalisation (AUC of 0.68, 95% CI: 0.62–0.74) compared to hospitalisation (AUC of 0.57, 95% CI: 0.52–0.63, $P = 0.01$) or death (AUC of 0.59, 95% CI: 0.53–0.65, $P = 0.046$). The *caregiver networks*' ability to manage mental and medical states predicted institutionalisation better than hospitalisation or death.

The AUC values for the global RISC scores, the caregiver components of the RISC, the CFS, the PHNs perception of frailty, and a battery of cognitive and functional instruments routinely collected by PHNs are presented in Table 2 and Figure 1. The global RISC scores most accurately predicted all three adverse outcomes. The *caregiver networks*' ability to manage ADLs (AUC of 0.68) had similar accuracy in identifying one-year risk of institutionalisation as the BI (AUC of 0.67, $P = 0.84$), the AMTS (AUC of 0.66, $P = 0.68$), and the CFS (AUC of 0.63, $P = 0.30$) but was significantly more accurate than the Charlson Comorbidity Index (AUC of 0.55, $P < 0.01$). The BI was significantly more accurate in predicting institutionalisation (AUC of 0.67 95% CI: 0.61–0.73, $P = 0.04$) and death (AUC of 0.65 95% CI: 0.60–0.71, $P \leq 0.05$) than hospitalisation (AUC of 0.58 95% CI: 0.50–0.61). The Charlson Comorbidity Index was a significantly more accurate predictor of death at one year (AUC of 0.66) than hospitalisation (AUC of 0.57), $P = 0.02$. The AMTS was only accurate for predicting institutionalisation (AUC of 0.66).

4. Discussion

This study describes the relationship between the components of the RISC across its three domains (mental state, ADL, and medical state), their accuracy in predicting the incidence of three adverse outcomes (institutionalisation, hospitalisation, and death), and the contribution that the components of the RISC provide in predicting each adverse healthcare outcome within one year of assessment, compared with a battery of assessment instruments, in a sample of community-dwelling older adults.

The results suggest that all components of the RISC were better able to predict institutionalisation than hospitalisation and death. The perceived ability of the *caregiver network* to manage patients' ADL was most accurate in predicting institutionalisation and hospitalisation. This component contributes much to the predictive power of the instrument as a whole. This would be expected, particularly for institutionalisation, as patients' social and caregiver networks play an important role in the mental [26] and physical health [27] of community-dwelling older adults. Indeed, caregiver burden is an established risk factor for all three adverse outcomes evaluated in this study [28].

The overall accuracy of the RISC subtests for predicting hospitalisation, within one year of the assessment, was poor. Only the perceived *severity* of concern of a patients' medical state and the ability of an individuals' *caregiver network* to manage a persons' ADLs had some, albeit weak (AUC < 0.60), ability to predict the one-year rate of hospitalisation. This difficulty in predicting hospitalisation was seen in the validation of the RISC [16] and may reflect the complexity associated with predicting hospital admission in such a frail population (median Clinical Frailty Scale score of 5/9). Several studies and instruments have been developed to predict readmission to hospital, many with poor accuracy [8]. The Hospital Admission Risk Profile, for example, stratifies patients into low, medium, and high risk based on three factors: age, cognitive function, and preadmission ADL function, with an AUC of 0.65 for predicting hospitalisation [29]. In part, this may relate to the fact that short risk prediction instruments fail to incorporate other complex factors influencing hospitalisation including system-specific and patient-specific factors [8]. While the RISC was designed to measure risk within one year, most instruments measure risk of hospitalisation or readmission within a short period such as 30 days [8]. Available studies predicting outcomes over longer periods, up

Table 1: Receiver operating characteristic (ROC) curve area under the curve scores and 95% confidence intervals (CI) for the global risk score and components of the Risk Instrument for Screening in the Community (RISC) scores including mental state, activities of daily living (ADL), and medical state domains, the primary caregiver, and primary cohabitant (who the patient is living with), for predicting one-year risk of institutionalisation, hospitalisation, and death.

Variable	Actual outcomes		
	Institutionalization	Hospitalization	Death
RISC global risk score (CI)	0.70 (0.62–0.76)***	0.61 (0.55–0.66)***	0.70 (0.64–0.75)***
Mental state			
Mental state *concern*	0.62 (0.55–0.69)***	0.52 (0.47–0.58)	0.56 (0.50–0.61)*
Mental state *severity* of concern	0.64 (0.57–0.71)***	0.53 (0.47–0.58)	0.56 (0.51–0.62)*
Mental state *caregiver network*	0.64 (0.57–0.71)***	0.53 (0.47–0.58)	0.56 (0.50–0.61)
ADLs			
ADLs *concern*	0.60 (0.54–0.66)**	0.55 (0.50–0.60)	0.56 (0.50–0.61)*
ADLs *severity* of concern	0.66 (0.60–0.72)***	0.54 (0.49–0.59)*	0.63 (0.58–0.69)***
ADLs *caregiver network*	0.68 (0.62–0.74)***	0.57 (0.52–0.63)**	0.59 (0.53–0.65)**
Medical state			
Medical state *concern*	0.54 (0.48–0.61)	0.52 (0.47–0.58)	0.53 (0.48–0.59)
Medical state *severity* of concern	0.62 (0.55–0.69)***	0.57 (0.52–0.62)*	0.62 (0.56–0.67)***
Medical state *caregiver network*	0.63 (0.56–0.69)***	0.54 (0.49–0.59)	0.56 (0.50–0.61)*

*Statistically significant with P value <0.05.
**Statistically significant with P value <0.01.
***Statistically significant with P value <0.001.

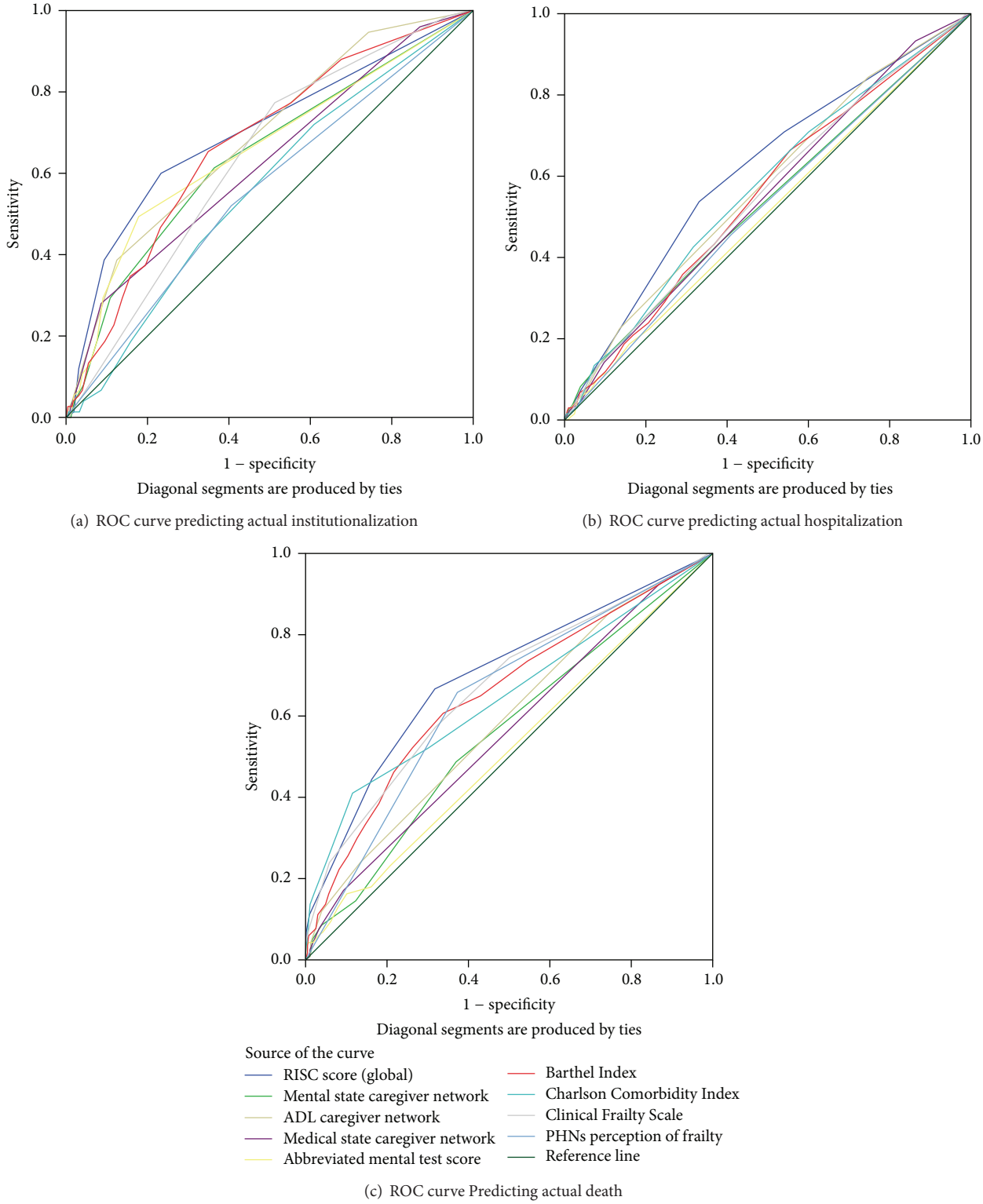
Table 2: Comparison of the accuracy and area under the curve (AUC) scores with 95% confidence intervals (CI), of the Risk Instrument for Screening in the Community (RISC), the caregiver network for each domain and a selection of cognitive and functional tests including the Barthel Index, abbreviated mental test score, Charlson Comorbidity Index, and the Clinical Frailty Score.

Variable	Institutionalization AUC (95% CI)	Hospitalization AUC (95% CI)	Death AUC (95% CI)
RISC global risk score	0.70 (0.62–0.76)***	0.61 (0.55–0.66)***	0.70 (0.64–0.75)***
Mental state *caregiver network*	0.64 (0.57–0.71)***	0.53 (0.47–0.58)	0.56 (0.50–0.61)
ADL *caregiver network*	0.68 (0.62–0.74)***	0.57 (0.52–0.63)**	0.59 (0.53–0.65)**
Medical state *caregiver network*	0.63 (0.56–0.69)***	0.54 (0.49–0.59)	0.56 (0.50–0.61)*
Barthel Index	0.67 (0.61–0.73)***	0.58 (0.50–0.61)*	0.65 (0.60–0.71)***
Abbreviated mental test score	0.66 (0.59–0.73)***	0.51 (0.46–0.56)	0.51 (0.46–0.57)
Charlson Comorbidity Index	0.55 (0.49–0.62)	0.57 (0.52–0.62)**	0.66 (0.60–0.72)***
Clinical Frailty Scale	0.63 (0.57–0.67)***	0.55 (0.50–0.61)*	0.67 (0.61–0.72)***
PHNs perception of frailty	0.56 (0.49–0.62)	0.53 (0.47–0.58)	0.64 (0.59–0.70)***

*Statistically significant with P value <0.05.
**Statistically significant with P value <0.01.
***Statistically significant with P value <0.001.

to one year, have found similar albeit higher accuracy [30]. Given that predictors of short- and long-term adverse healthcare outcomes are likely to be different [31], the accuracy of the RISC in predicting hospitalisation within one year seems reasonable. The accuracy of the RISC for predicting one-year mortality was superior to hospitalisation. This was consistent with other studies [32, 33] including those incorporating multidimensional interdisciplinary CGA, which is a better predictor of one-year mortality than comorbidity or prognostic indices [34]. The reasons for this are complex and unclear. The factors predicting hospitalisation and hospital readmission are more complex than those predicting death and include hospital and healthcare system-level factors which are often location specific and cannot easily be incorporated into short and generalizable risk prediction models [8, 33]. Further, while these outcomes are not mutually exclusive, not all hospitalisations result in death and vice versa.

Comparing the accuracy of the other instruments used in the CARTS study to the components of the RISC suggests that the *caregiver network* component of the RISC (ADLs) had comparable accuracy in identifying risk of institutionalisation as the Clinical Frailty Scale, a marker of frailty. Likewise, both had similar accuracy for one-year mortality. The Charlson Comorbidity Index, a well-validated measure of comorbidity studied across a wide variety of clinical settings, was better able to predict mortality than hospitalisation. This is similar to the Cumulative Illness Rating Scale [35], another measure of comorbidity, which is more accurate at predicting



(a) ROC curve predicting actual institutionalization

(b) ROC curve predicting actual hospitalization

(c) ROC curve Predicting actual death

Figure 1: Receiver operating characteristic curves demonstrating the accuracy of the Risk Instrument for Screening in the Community (RISC), mental state, activities of daily living (ADL) and medical state domains, the abbreviated mental test score (AMTS), Barthel Index, Charlson Comorbidity Index, Clinical Frailty Scale, and public health nurses' (PHNs) perception of frailty in identifying one-year risk of (a) institutionalisation, (b) hospital admission (at least one), and (c) death.

institutionalisation than death [24]. The BI, a measure of ADL had similar accuracy to a measure of cognition (AMTS) in predicting institutionalisation. This would be expected given that function is important in determining nursing home placement in patients with [36] and without cognitive impairment [37]. This was mirrored in the greater accuracy of the *caregiver networks*' ability to manage ADL over its ability to manage patients' mental state.

The strengths of this study are the large numbers of community-dwelling older adults included and the comprehensive nature of the PHN records and that the instrument was validated in a sample of urban-suburban community-dwelling older adults in busy health centres. Another strength is that this tool employs a simple Likert scale to score the ability of the caregiver network to manage concerns in three domains. To our knowledge, there is no other instrument that measures the caregiver network in this way. This study does have limitations. Collection of demographic data was based upon a retrospective review of the patients' PHN records. Furthermore, the sample only included patients under active follow-up by their PHN, which may have created selection bias. Likewise, patients were predominantly functionally independent (median BI score of 18), cognitively intact (median AMTS score 10), and without significant comorbidity (median Charlson Comorbidity Index score of one), which may also have contributed to this bias. However, most patients were mildly frail as judged by the CFS (median score of five). Future studies should investigate the use of the RISC in other populations including those not under PHN surveillance and those more or less frail than this current sample. As the RISC is designed to detect outcomes within one year of assessment, the "predictive window" in this study differs from other studies, reducing the ability to directly compare outcomes and predictive validity. Likewise, the performances of many of the RISC subtests were low with AUCs at best between 0.6 and 0.7. This generally indicates low accuracy in correctly identifying outcomes [38]. That said, the objective of this study was to compare a lengthy battery of assessment instruments with a single, short subjective screen for risk. The accuracy of the test compares favourably with the other instruments included in this study and in other published papers.

5. Conclusion

In conclusion, the ability to identify high-risk individuals constitutes the first step in any strategy to target vulnerable, frail patients. The RISC is a short, reliable, and validated risk prediction screen for use in the community to identify risk of adverse healthcare outcomes. The RISC is similar to other short screening instruments like the Clinical Frailty Scale, the application of which, like the RISC, requires judgment and a degree of subjectivity [24]. In this study, the most accurate RISC subtest for institutionalisation was the ADL *caregiver network*. The most accurate subtest for death was ADL *severity*. The measurements of internal consistency suggest that all components of the RISC contribute to the overall predictive validity of the instrument. The RISC performed better than a selection of other assessment instruments, routinely collected by PHNs, in this sample of community-dwelling older adults. Further research is now required to compare the RISC with other validated risk tools, single-question screens, frailty measures, and comprehensive assessment instruments such as the InterRAI [39].

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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