Effects of a workplace-based lifestyle intervention on the physical activity levels of a sedentary occupational group

Maura Lawless, RGN, BN, MSc Preventive Cardiology

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Abstract

Background: Physical inactivity is a leading risk factor for premature mortality globally. Rapidly advancing technologies have contributed to physical inactivity and prolonged periods of sedentary behaviour (SB). The workplace environment has been identified as a key setting to facilitate and support physical activity (PA) behaviour. The aim of this study was to evaluate the effects of an Irish Healthcare workplace-based lifestyle intervention 'Hospital Walks', on the PA levels of a sedentary occupational group.

Design: A descriptive cross-sectional design study.

Methods: A cohort of 32 administrative employees at Roscommon University Hospital (RUH) were assessed on their PA levels prior to and following the introduction of the 'Hospital Walks' intervention. The International Physical Activity Questionnaire-Short Form (IPAQ-SF) subjectively measured PA, while the ActivPAL 3c accelerometer objectively measured PA.

Results: Following the intervention there was a 19.4% increase in PA participation >10,000 steps per day. The study revealed a statistically significant increase in participants' mean steps per day (P=0.018). Subjective median sitting, and objective mean measures of sitting plus lying time per day, were virtually unchanged from preliminary measures taken, at 6 hours and 17.40 hours respectively.

Conclusion: The 'Hospital Walks' intervention demonstrated a positive impact on the PA levels of office-based administration employees. There was a significant increase in PA participation, however SB time was essentially unchanged following the intervention. This study recommends the creation of a workplace environment that is conducive to PA participation, with additional parallel strategies to reduce prolonged SB time in office-based employees.

Key words: Workplace, physical activity interventions, sedentary behaviour, physical activity measurement.

Introduction

Physical inactivity is regarded as one of the greatest health challenges facing developed countries to date.[1] As a leading risk factor for mortality globally, it accounts for an estimated one million deaths per year within the European region.[2] Physical inactivity is associated with a wide range of chronic disease conditions such as coronary heart disease, type two diabetes, cancer and premature mortality.[1,3] The most recently published INTERSTROKE study of 32 countries reveals the incidence of stroke would be cut by 36% if individuals were more physically active.[3]

There is a wealth of evidence to substantiate the affirmation that physical activity (PA) improves one's quality of life, prevents disease, enhances mental health and wellbeing; while fostering social and economic gains.[1,3-10] Participation in PA is a mainstay in cardiovascular disease (CVD) prevention.[4] The World Health Organization has set a 10% global target reduction in physical inactivity by the year 2025.[11] However in Ireland, only one in three individuals are achieving the recommended levels of PA, and 60% of the population are either overweight or obese.[12] Based on estimates from the World Health Organization, the burden of physical inactivity in Ireland, through health care provision and loss in economic output due to illness, is reported to potentially cost €1.5 billion each year.[8]

The modernisation of our society, coupled with rapidly advancing technologies within our home and work practices has led to physical inactivity and prolonged periods of sedentary behaviour (SB).[13,14] SB, characterised by low rates of energy expenditure in a seated or a reclining position, is prevalent in the realms of leisure or recreation, occupation and transportation.[15-17] Evidence from a wide range of observational studies and systematic reviews of varying ethnic population groups across the globe, have demonstrated a distinct

correlation between SB and an increased risk of various chronic disease conditions, plus all-cause mortality.[15,16,18-29]

CVD is the single largest cause of disability and death in Ireland, accounting for 31% to diseases of the circulatory system.[30,31] Results from a recently conducted Irish survey reveal the average amount of time an individual spends sitting each day is six hours thirty-six minutes;[12] whilst a large cross-sectional survey in the United Kingdom identified office based workers to be spending up to 75% of their working time sitting.[32] Reducing physical inactivity time is as much about decreasing SB time at home, in leisure or work as it is about attaining the recommended 150 minutes of moderate intensity PA in the week.[33]

As research has shown many individuals spend the largest portion of their sitting time at work,[15,32,34,35] the workplace environment has been identified as a key setting to facilitate and support PA behaviour. Employers are encouraged to explore possibilities to maximise supportive environments for PA in the workplace.[8,11] Previously population-based interventions such as tobacco control legislation in workplaces and communities, have proven to be successful.[12] In a rapidly growing technological era, there is a great need to identify specific approaches to increase PA behaviour, reduce SB time, and subsequently reduce the risk of CVD. As workplace SB is higher among office based workers,[15,36] a focus on specific operational strategies to help prevent or reduce the onset of chronic disease in this select occupational group is a priority.

In Ireland, there is a dearth of research studies carried out on workplace PA interventions. However, those that are available have demonstrated effectiveness and feasibility in terms of PA participation.[37-40] Globally, there is an extensive volume of literature examining the effects of workplace health promotion interventions on PA

behaviour in sedentary workers, yielding positive results.[36,41,42] Limitations have been identified in many studies, in regard to sustainability and long-term potential.[36,42] However, as per the most recent European guidelines on CVD prevention, participation in multiple short sessions of ≥10 minutes of PA,[4] is potentially feasible within the workplace.

There are methodological short-comings evident within the literature, in regard to validated and objective measures of PA utilised, incorporating step-taking and sitting time.[36,43,44] There is a gap and need for more robust study designs, utilising validated and objective measures of PA. This will help strengthen the evidence base and inform best practice guidance measures in support of both national and global goals, to increase PA participation, while contributing to a reduction in the prevalence of CVD. Consequently, the aim of this study was to evaluate the effects of an Irish healthcare workplace-based lifestyle intervention – 'Hospital Walks', on the physical activity levels of a sedentary occupational group.

Methods

Study design

A descriptive cross-sectional design was employed to examine sedentary office-based workers within a healthcare facility. The study is capable of collating a range of data on the studied phenomenon and generate information that can be explored further, which constitutes a descriptive design.[45,46] The 'Hospital Walks' initiative was developed and designed by the Healthy Ireland Health Promotion department and the Saolta University Healthcare Group in the West of Ireland to support and encourage staff to incorporate exercise breaks into their day.

A cohort of office-based administration employees from Roscommon University Hospital (RUH) were assessed on their PA levels prior to and following the introduction of RUH 'Hospital Walks' intervention. The Saolta University Healthcare group and Healthy Ireland Lead advertised and launched RUH 'Hospital Walks' website plus interactive maps. It demonstrated measured walking routes, from eight to forty minutes in length, within and surrounding the hospital site (Appendix 1). The participants also received an email each week with guidance on PA as per the most recent European guidelines on CVD prevention.[4]

Study population

Convenience sampling was used in the recruitment of study participants at RUH. All administration staff in RUH were informed of the study though the postal distribution of information leaflets. No reminder mechanism such as an email or phone messaging was used. The maximum number of participants in the study was projected at 50 as this was the total number of administration employees at RUH.

Included in the study were male and female individuals, aged between 18 years and 70 years, currently working as administration employees at RUH. Excluded were non-administration employees, aged less than 18 years or greater than 70 years. A total of 36 subjects responded to participate in the study, with written informed consent provided.

Data collection

The study participants were asked to complete the International Physical Activity Questionnaire-Short Form (IPAQ-SF). The self-report questionnaire is a validated, reliable tool, which is widely used and demonstrates good reproducibility. It measures PA across four domains inclusive of leisure, domestic, work and transport related activity, over a period of seven days.[47] Demographic information, including smoking status, rating of overall health and wellbeing, and knowledge of the current PA recommendations was also documented. Participants were asked to complete the questionnaire on two separate periods, prior to and following the introduction of the 'Hospital Walks' intervention via SurveyMonkey (an international web-based anonymous survey tool), with an interval of four weeks. A link to the questionnaire was emailed to each participant.

PA was objectively measured via accelerometer devices. Step count, plus sitting and lying time was obtained through ActivPAL 3c monitors which have demonstrated excellent reliability and validity when used in PA and SB research.[48] Each participant was shown how to wear the accelerometer on their thigh. The devices were worn by the participants for two periods of seven consecutive days, before and after the introduction of the 'Hospital Walks' intervention, with an interval of four weeks. A study pack comprising of accelerometer, participant information leaflet, written and visual device information, plus an envelope to return individual monitors was presented to each participant. A designated date, time and

location was given to all participants for return of monitors containing anonymous data into a deposit box on the hospital grounds. Participants were informed to complete questionnaire over the same time period as the accelerometer recording. Data was collected prior to and following the introduction of the 'Hospital Walks' intervention over a six week period. Hard copies were stored in a secure off-site location; electronic data was stored securely in a password protected computer.

Statistical analysis

Statistical analysis was undertaken using the Statistical Processing for the Social Sciences (SPSS) software, version 23. Subjective measures of total PA per week were collated from leisure, domestic and work-related activity domains via the IPAQ-SF questionnaire, and computed as per data processing and analysis guidelines.[49] Categorical scoring from the IPAQ-SF was accumulated from the total volume and number of per week and broken into three categories of total PA. The inactive category is the lowest level of PA where individuals are classified as insufficiently active. The minimally active category is attained if individuals achieve ≥150 minutes moderate intensity activity or ≥60 minutes vigorous activity or activities achieving ≥600 MET-minutes per week. The high active – Health Enhancing Physical Activity (HEPA active) category scores individuals who reach at least ≥1.5 - 2 hours total activity, of moderate intensity (at minimum), per day. Continuous scoring of total PA MET-minutes per week were computed from median values of combined walking, moderate and vigorous intensity activities. Data scoring on sitting time was reported in median values, as per the IPAQ-SF guidelines.[49]

Continuous mean steps per day were measured over two seven day periods from ActivPAL-based data. Comparable to other studies,[50,51] mean steps per day were then

classified into: Low (<5,000 steps per day), moderate (5,000–10,000 steps per day) and High (>10,000 steps per day) categories. Mean sitting and lying time over seven days was calculated from ActivPAL-based data.[50,51] Statistical analysis of data was performed using Paired Samples T Test, Wilcoxon Signed Rank Test, one-way ANOVA and Chi-Square; Correlation was undertaken using Pearson, and Spearman's rank order. Statistical significance is reported at $p < 0.05$ level.

Ethical approval

Full ethical approval was attained from Galway University Hospitals Clinical Research Ethics committee (reference: C.A. 1673).

Results

A total of 36 individuals enrolled in the study at onset, representing a response rate of 72% from the total cohort of administration employees present at RUH. Where participants failed to complete questionnaires, or failed to wear ActivPAL monitoring devices following the intervention due to illness or unexplained leave, they were excluded from the analysis. Full data was obtained from 32 participants who completed the study, representing 64% of the total cohort. 90.6% (n=29) of participants were female, and 9.4% (n=3) were male. Mean age of study participants was 50, working at mean 4.52 days per week, representing 0.9 full-time equivalence. 59% (n=19) of participants were aged from 49–67 years. Demographic characteristics of the study sample are presented in Table 1.

Table 1. Demographic characteristics of participants.

	% (n)	Age (years) Mean (SD)	Number of days worked Mean (SD)	Smoker % (n)	Ex-smoker % (n)	Non-smoker % (n)
Participants	100 (32)	50 (9.65)	4.52 (0.91)	12.5 (4)	18.8 (6)	68.8 (22)
Gender						
Male	9.4 (3)	45 (11.06)	3.67 (2.31)	0 (0)	0 (0)	9.4 (3)
Female	90.6 (29)	50 (9.65)	4.62 (0.64)	12.5 (4)	18.8 (6)	59.4 (19)

IPAQ-SF subjective measure

Following the introduction of the 'Hospital Walks' intervention, data analysis demonstrated a 6.7% reduction in the number of participants within the inactive category of PA when compared to initial measures taken. There was a 10% increase in participants undertaking a combination of walking, plus moderate intensity activity and vigorous intensity activity (HEPA active) on at least seven days per week, which is deemed to achieve maximum health gains (Figure 1).[49] Furthermore, there was a 6.7% increase in the total number of participants achieving the recommended level of PA,[4] or above it (minimally active plus HEPA active categories). The difference in proportions was not statistically significant when compared using Chi-Square Likelihood Ratio (p=0.155).

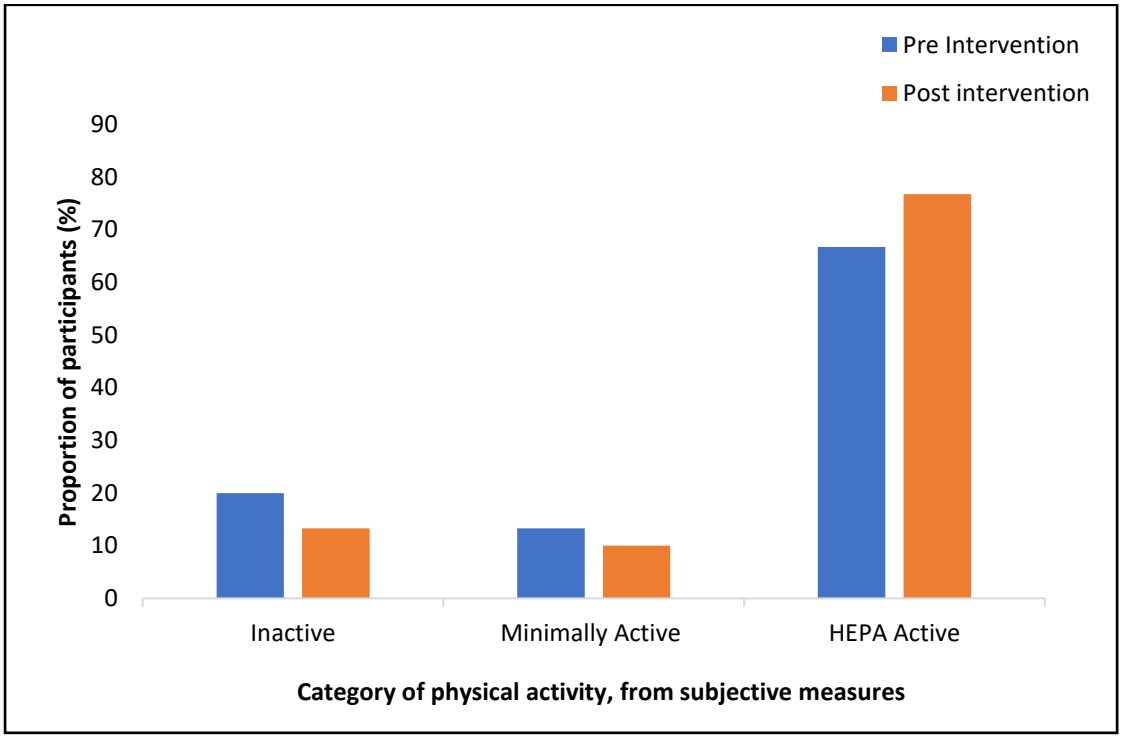


Figure 1. Categories of physical activity pre and post the intervention, from IPAQ-SF.

Continuous measures of IPAQ-SF data were analysed as median MET-minutes per week of PA, as per the IPAQ-SF guidelines.[49] An increase of 2873 median MET-minutes in PA per week was noted following the intervention in male participants (n=3). In comparison, female participants (n=29) had a median increase of 573 MET-minutes per week. For all participants (n=32) initial measures reported at 2147 median MET-minutes per week, and following the intervention it increased up to 2868 median MET-minutes (Table 2). This difference was shown to be non-significant when compared using Wilcoxon Signed Rank Test (p=0.107).

Table 2. Physical activity and sedentary behaviour time pre and post the intervention.

	% (n)	IPAQ-SF MET-Minutes per week Median		IPAQ-SF Daily sitting time (hours) Median		ActivPAL Daily number of steps Mean (SD)		ActivPAL Daily sitting and lying time (hours) Mean (SD)	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
Participants	100 (32)	2147	2868	6.0	6.0	8626 (2294.20)	9803 (2874.00)	17.38 (1.29)	17.40 (1.72)
Gender									
Male	9.4 (3)	2017	4890	5.0	8.0	8931 (1488.50)	12061 (3263.10)	17.02 (2.91)	15.37 (2.97)
Female	90.6 (29)	2226	2799	6.0	6.0	8593 (2381.72)	9561 (2786.00)	17.42 (1.09)	17.62 (1.46)

Subjective IPAQ-SF median sitting hours per day was measured. Male participants (n=3) reported a three hour increase in median sitting time per day following the intervention totalling at eight hours, despite having reported an increase in PA participation. This was not replicated in female study participants (n=29) who reported an unchanged six hours median sitting time per day before and after the intervention; as was also the reported equivalent for all participants (n=32). The total number of days of all PA (vigorous, moderate and walking) per week was analysed. It demonstrated a mean increase in all PA of 1.67 days, but following Wilcoxon Signed Rank test, the difference in means was of low statistical significance (p=0.055).

ActivPAL objective measure

Following the introduction of the 'Hospital Walks' intervention, analysis of ActivPAL measures of PA revealed the recommended >10,000 steps per day (high active participation) was attained by 45.2% of individuals (n=14) in this study. 54.8% (n=18) participated in moderate activity (5,000–10,000 steps per day), with no participant remaining in the low active classification of <5,000 steps per day (sedentary category), in contrast to initial measures. There was a 19.4% increase in PA participation to the high active category (Figure 2). The difference in proportions in the category of steps prior to and following the intervention, using Chi-Square Likelihood Ratio Test was not of statistical significance (p=0.089).

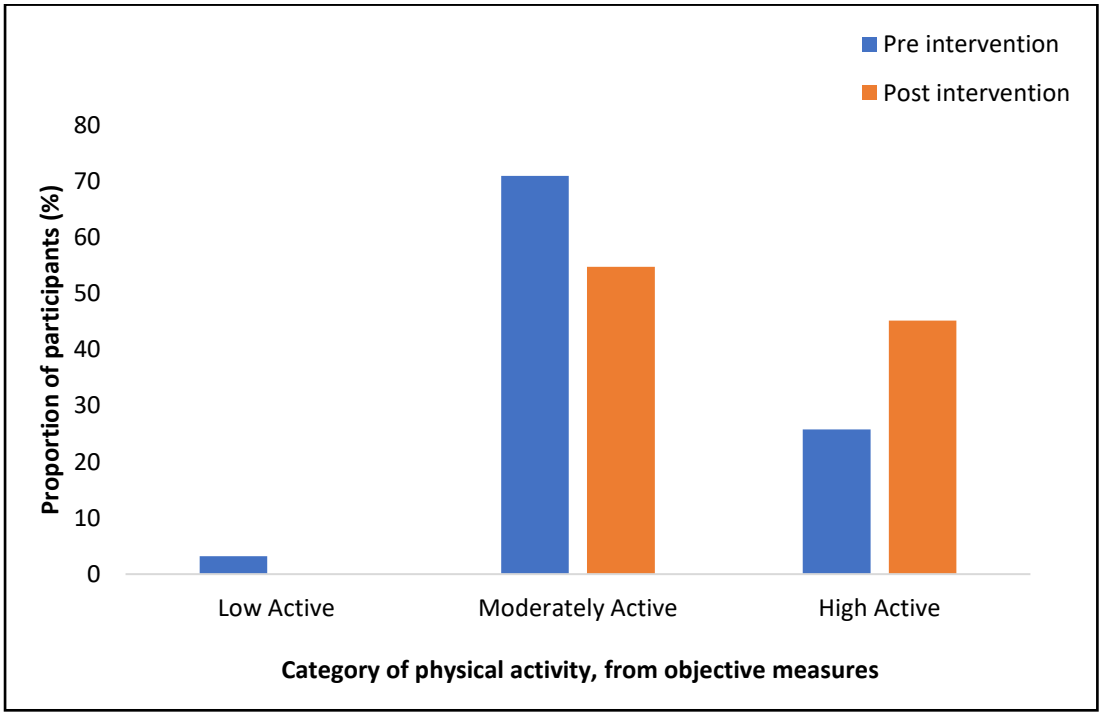


Figure 2. Categories of physical activity (steps) pre and post the intervention, from ActivPAL.

Continuous measures of ActivPAL-based data were analysed. An increase of 3130 mean steps per day was noted following the introduction of the 'Hospital Walks' intervention in male participants (n=3), in comparison to a 968 mean step increase in female participants (n=29). For all study participants (n=32) post intervention, mean steps per day returned at 9803, demonstrating a 1177 mean step increase from preliminary measures taken (Table 2). When compared, using parametric Paired Samples T Test, the difference in means was statistically significant (p=0.018).

Within the 30–48 year old age group following the intervention, a higher proportion of individuals at 42.9%, walked >10,000 mean steps per day; while in contrast in the 49–67 year age group a higher proportion of 64.7% were moderately active walking 5,000–10,000

mean steps per day (p=0.475). Bivariate Spearman's rho correlation revealed a non-statistically significant negative relationship between age and mean steps per day (r=0.022, p=0.906).

Sitting and lying time over 24 hours demonstrated high SB prevalence, ranging from 11.94 hours to 20.40 hours. Before and after the intervention, sitting plus lying time showed only slight dissimilarity at 17.38 and 17.40 mean hours respectively. Despite demonstrating a statistically significant increase in objectively measured PA participation subsequent to the intervention, mean sedentary time was virtually unchanged. Notably, analysis of female participants (n=29) following the intervention, revealed a slight increase in their objective measures of SB time from 17.42 hours up to 17.62 hours (mean); while in stark contrast male participants (n=3) demonstrated a decrease from 17.02 to 15.37 mean hours (Table 2).

IPAQ-SF and ActivPAL comparisons

Analysis using Spearman's rho correlation on post intervention measures, revealed a weak positive relationship between self-reported median total time walked (37.5 minutes) in a day and objectively measured mean steps (9803) per day (r=0.062) of non-significance (p=0.749). Objective measures of PA (ActivPAL) showed a mean step per day increase of 13.66%. This percentage increase was not comparable to subjective measures of PA (IPAQ-SF), where median MET-minutes per week revealed an increase of 33.58% following the intervention.

A small positive relationship of weak significance was noted, from post intervention measures, between self-reported sitting time per day and objectively measured sitting plus lying time, using Pearson's correlation (r=0.217, p=0.258). From initial to subsequent measurements of SB time, male participants (n=3) self-reported an increase of three median

hours sitting per day; while in stark contrast objective measures demonstrated a mean 1.65 hour reduction in sitting plus lying time per day in males. In all participants (n=32) when compared, both subjective median sitting and objective mean sitting plus lying time, was virtually unchanged following the introduction of the 'Hospital Walks' intervention.

Physical activity, perceived rating of health and wellbeing

Analysis revealed participants who rate their health as very good or excellent at post intervention measures, have shown to walk more steps per day, mean 10528 and 13461 respectively, when compared to participants who rate their health as fair or good. Those who rate their health as fair walk less. Strong evidence concludes from ANOVA that the mean steps per day differ significantly between groups of participants' rating of their overall health and wellbeing (p=0.031). Post-hoc comparisons using Scheffee test shows that the mean steps per day from participants who rate their health as excellent 13461 (2162.9) was higher and near statistical significance (p=0.057), 95% CI [-98.38, 9522.34] in comparison to participants who rate their health as good 8749 (2827.95). The mean difference was 4711.98 steps per day lower for the good category (Table 3).

Table 3. Relationship between groups of participants rating of their overall health and wellbeing, smoking status, knowledge of physical activity recommendations with physical activity and sedentary behaviour.

	Mean difference Steps per day	Mean difference Sedentary time (hours)	Post-hoc p-value[a]	Post-hoc 95% CI
Rating of overall health and wellbeing				
Good versus Fair	557.86		0.993	-5157.70, 6273.42
Excellent versus Good	4711.98		0.057	-98.38, 9522.34
Excellent versus Fair	5269.83		0.184	-1632.36, 12172.03
Rating of overall health and wellbeing				
Excellent versus Good		-3.04	0.052	-6.1049, 0.0163
Excellent versus Fair		-1.97	0.620	-6.3616, 2.4216
Smoking status				
Non-smokers versus Ex-smokers	3557.7		0.020	504.91, 6610.42
Knowledge of current PA recommendations*				
30 minutes moderate pace physical activity 5 days per week versus 40 minutes moderate pace physical activity 5 days per week	2170.17		0.361	-1700.64, 6040.97

[a]ANOVA post-hoc Scheffee test. p-value <0.05 indicates statistical significance.

*Equates to 30 minutes moderate pace physical activity 5 days per week.

Sedentary behaviour, perceived rating of health and wellbeing

Following the intervention, the relationship between the participants' rating of their overall health and wellbeing and objectively measured mean SB time (sitting plus lying), per day was examined. Analysis revealed participants who rate their health as excellent are less sedentary each day (mean of 15.03 hours) when compared to participants who rate their health as good. Strong evidence concludes from ANOVA, that the mean SB time per day differs significantly between groups of participants' rating of their overall health and wellbeing (p=0.044). Post-hoc comparisons using Scheffee test shows that the mean SB time per day of participants who rate their health as excellent 15.03 (2.68) was lower but not statistically significant (p=0.052), 95% CI [-6.1049, 0.0163] in comparison to participants who rate their health as good 18.07 (1.42). The mean difference was 3.04 hours less sedentary per day for the excellent category (Table 3).

Smoking status and physical activity

Analysis using one-way ANOVA reveals that participants at post intervention measures who are current smokers or non-smokers walk more steps per day, mean 8707 and 10683 respectively, when compared to ex-smokers. Those who are ex-smokers walk less at 7125 mean steps per day. Strong evidence concludes that following the 'Hospital Walks' intervention, the objectively measured mean steps per day differ significantly between the groups (p=0.016). Post-hoc comparisons using Scheffee test shows that the mean steps per day from participants who are non-smokers 10683 (2751.55) was higher and statistically significant different (p=0.020), 95% CI [504.91, 6610.42] in comparison to participants who are ex-smokers 7125 (1826.8). The mean difference was 3558 steps per day lower for the ex-smoker category (Table 3). The mean difference when comparing the

non-smokers and the current smoker categories was 1976 steps per day lower for the current smoker category (p=0.466) 95% CI [-2103.08, 6055.75].

Knowledge of physical activity recommendations

Prior to the 'Hospital Walks' intervention, assessment measures revealed 32% of participants had an accurate knowledge of the current adult PA recommendations (30 minutes moderate pace PA five days per week)[4] and walked 9040 mean steps per day. This increased to 41% of participants being knowledgeable of the current PA recommendations following the intervention, and they walked the highest number of steps per day, at mean 10789. The evidence concludes following analysis using one-way ANOVA, the mean steps per day was not statistically significant between groups of participants with varying knowledge of the current adult PA recommendations (p=0.274).

Discussion

Technological advances in modern society has contributed to physical inactivity trends and prolonged periods of SB in the workplace.[12,13] Over the past number of years, various health promotion PA interventions have been introduced to many workplaces.[36,41] This pre and post analysis study set out to evaluate the effects a health promotion 'Hospital Walks' intervention (with PA guidance emailed weekly), on the PA levels of office-based administration employees. The first of its kind in Ireland, this study utilised validated, reliable measures of PA incorporating accelerometer step count, plus sitting and lying time. The sample was predominantly female which is consistent with administrative employee population groups in Ireland.[52] There was some disparity evident among objective and subjective findings, which has also been noted elsewhere,[44,53] however post intervention there was a substantially positive increase in overall PA levels.

Subsequent to the introduction of the 'Hospital Walks' intervention, accelerometer data revealed a statistically significant increase in participants' mean steps per day. There was a 19.4% rise in PA participation within the high active category (achieving >10,000 steps per day); and positively following the intervention, no participant remained in the low active classification of <5000 steps per day. This result supports European guideline recommendations,[5] that individuals who are at low activity baseline are encouraged to gradually increase their PA participation.

Following the intervention, study participants self-reported an increase in their weekly participation of walking plus moderate and vigorous activity up to 1.67 days. While of low statistical significance, a trend was observed towards an increase in PA behaviour. These findings were comparable to two similar workplace interventional studies of office-

based employees. Although both studies demonstrated a significant interactive effect, they were lacking concurrent and robust objective measures of PA.[38,43]

The most active age group identified in this study was the 30 - 48 year old category, achieving the recommended >10,000 steps per day, which is consistent with literature findings.[50] Although a low number of male subjects participated in this study (n=3), notably they achieved the greater increase in PA levels from both subjective and objective outcome measures, following the introduction of the 'Hospital Walks' intervention. This finding is comparable with a previous national population based study, which utilised the same subjective measurement tool.[50] However it must be noted that the mean age of male participants in this study was five years younger than their female counterparts, which may explain to some extent the disparity.

As identified within the literature, the monitoring of PA through wearable accelerometer devices such as the ActivPAL 3c in this study, may inadvertently motivate or prompt PA participation.[54] It was acknowledged that these devices may have been a contributory source of bias and have potentially created competitiveness among study participants. As this was not an objective of the study, participants were prior informed to focus solely on their own personal PA behaviours.

SB time was observed from accelerometer and questionnaire data. Consistent with the evidence, high levels of SB time was evident within this select occupational group.[36,55] Self-reported daily sitting time in all participants was comparable with national figures at 6 hours (mean).[12] Following the introduction of the PA intervention, both subjective and objective measures of SB time were almost unchanged from preliminary measures taken. This demonstrated virtually no effect of the PA intervention on SB time. Despite objectively

illustrating a statistically significant increase in PA participation subsequent to the intervention, participants' time spent sedentary was essentially unchanged. The findings highlight that individuals can be physically active, meeting the recommended 150 minutes of moderate intensity PA per week or >10,000 steps per day, but still engage in prolonged periods of SB, and is consistent with the literature.[29,43,56]

Objective measures of SB time at baseline, revealed participants were sedentary (sitting plus lying) for 17.38 mean hours in a twenty four hour period. Under the assumption that an individual sleeps for an average of eight hours per night, it would indicate 9.38 hours of their waking time was sitting. This is three hours (almost 50%) higher than a recent national survey reported at 6.36 hours, which was subjectively measured from the general population.[12] While cognisant that this studied cohort are notably a sedentary occupational group, the findings nevertheless are alarming, considering the health implications associated with prolonged SB.[15,16,18]

Variations in the results of IPAQ-SF and accelerometer measures of PA were identified in this study. Previous studies highlighted that different measures of PA can lead to a variation in results.[57,58] To measure PA, the optimal tool must encompass different types of activity, under different domains, frequency, intensity and duration.[57] This research study endeavoured to include all components in its measures of PA. However, the findings following the intervention demonstrated an increase in subjective measures of PA (median MET-minutes) greater than twice that of the increase in objective measures (mean steps). It is acknowledged that when utilising self-reported measurement tools, an under-reporting or over-reporting of effects can result, due to social desirability and recall bias.[42] This is a potential reason for the disparity in some findings of this study, and supported by the

literature where studies have shown individuals can over estimate their participation in self-reported measures of PA.[50,59]

Sitting time in male participants identified a subjective median increase of 3 hours per day following the 'Hospital Walks' intervention, while objective measures revealed a 1.65 hour mean reduction per day. Conversely, an under estimation of reported sitting time is apparent within the literature.[59] As there was a low number of male subjects (n=3) participating in this present study, further exploration of this finding is recommended, to ascertain if a differentiation between male and female gender exists on perceived SB time.

Overall there was a low to moderate correlation of data on PA participation from accelerometer and IPAQ-SF measures when compared, consistent with the evidence.[44,53] However, a non-significant positive relationship was identified between subjectively measured walking and objectively measured steps per day. This relationship was similar to earlier studies where individuals who subjectively reported to be walking more, had a higher objective step count.[60]

Potential confounders to an increase in PA were explored in this study. Strong evidence revealed that participants who perceived their health as excellent objectively walked more steps and were less sedentary each day, than those who perceived their health as fair or good. However this was statistically non-significant. This finding supports the literature that a distinct positive relationship exists between PA participation and health and wellbeing.[8,61]

An incidental finding in this study revealed, non-smokers were more physically active, and walked significantly more steps per day than ex-smokers. In addition, current smokers walked 20% more steps than ex-smokers. A comparable report to this finding could

not be found in the literature. However due to limitations of this study, specific detail on the length of time participants reported to be ex-smokers, or whether their previous smoking history had reduced their capacity to undertake PA, could not be explored. Further examination of this novel finding is recommended.

This research study of hospital administration employees showed following the intervention, there was a non-significant 9% increase in participants who had accurate knowledge of the current PA recommendations. Concurrently these participants walked the highest number of steps, when compared to individuals who self-reported alternate erroneous PA recommendations. This finding demonstrated a positive trend of knowledge equating to activity, thereby supporting the importance of the broader determinants of health such as education, in health behaviour change.[8,9,11]

Taking into consideration that the study participants work in a healthcare facility, only 32% of individuals at initial measures, had an accurate knowledge of the current PA recommendations. As the findings have highlighted, it is important that healthcare employees are correctly informed of these recommendation, for the benefit of their own health and also of the public they meet as part of their role. Nevertheless, while there was a non-significant increase in participants having the accurate knowledge of the current PA recommendations following the intervention, there was a statistically significant increase in objectively measured PA participation.

Study limitations

This pre and post analysis study would have been further enhanced with repeated measures taken at six months and one year. Due to constraints within the study time-frame,

it was not possible on this occasion. The findings would help ascertain the long-term potential and sustainability of the 'Hospital Walks' intervention.

As a new innovative PA intervention, this study was carried out onsite at RUH. Since study completion, the 'Hospital Walks' initiative is now in place at seven hospital sites in the West of Ireland. The inclusion of some or all of these locations in a multi-site study would strengthen and enhance the evidence-base.

The accurate identification of additional specific activity such as differentiating sitting from lying, and sleep from waking time, are proposed new areas of design among ActivPAL and accelerometer devices.[48] The expansion of such specifics in objectively measured monitoring would have further enhanced this study.

Recommendations

This research study precedes the introduction of the National Healthy Workplace Policy Framework in Ireland next year, a key milestone in workplace health. Based on the findings contained in this study, the 'Hospital Walks' intervention made a significantly positive impact on the PA levels of sedentary administration employees at RUH. It is a recommendation that a related multi-site study is carried out in the other 'Hospital Walks' location sites in the West of Ireland, to compare with these findings. As an inexpensive population-based environmental model, it is also an approach that may be adapted to other workplace locations and communities alike.

In support of this research, there is a need for additional well designed robust studies on PA interventions, to strengthen the evidence-base and inform effective best practice in the workplace. Such studies should include repeated measures to determine

sustainability and long-term effectiveness of the interventions. As substantially high levels of SB time was identified in this occupational group, specific targeted interventions to address prolonged SB in office-based workers are also warranted.

Conclusion

This studied workplace-based lifestyle intervention - 'Hospital Walks', had a profoundly positive impact on the PA levels of a sedentary occupational group in the West of Ireland. Subsequent to the introduction of the intervention, there was a statistically significant increase in participants' objectively measured mean step count per day. It affirms national and global recommendations that supportive environs for walking and PA are a vital determinant of PA behaviour. Conversely, the 'Hospital Walks' intervention had almost no effect on participants' SB time. The creation of a workplace environment that is conducive to PA, with parallel strategies to reduce prolonged SB time is essential for office-based administration employees. The findings in this study will inform best practice measures, in support of the World Health Organization global goal for a reduction in physical inactivity trends by 2025.

Conflict of interest

None declared.

References

1. Ding D, Lawson KD, Kolbe-Alexander TL, et al. The economic burden of physical inactivity: a global analysis of major non-communicable diseases. *Lancet*. 2016; 388(10051):1311-24.

2. Reis RS, Salvo D, Ogilvie D, et al. Scaling up physical activity interventions worldwide: stepping up to larger and smarter approaches to get people moving. *Lancet*. 2016; 388(10051):1337-48.

3. O'Donnell MJ, Chin SL, Rangarajan S, et al. Global and regional effects of potentially modifiable risk factors associated with acute stroke in 32 countries (INTERSTROKE): a case-control study. *Lancet*. 2016; 388(10046):761-75.

4. Piepoli MF, Hoes AW, Agewall S, et al. 2016 European Guidelines on cardiovascular disease prevention in clinical practice: The Sixth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of 10 societies and by invited experts) Developed with the special contribution of the European Association for Cardiovascular Prevention & Rehabilitation (EACPR). *EHJ*. 2016; 37(29):2315-81.

5. Ekelund U, Steene-Johannessen J, Brown WJ, et al. Does physical activity attenuate, or even eliminate, the detrimental association of sitting time with mortality? A harmonised meta-analysis of data from more than 1 million men and women. *Lancet*. 2016; 388(10051):1302-10.

6. Global Advocacy Council for Physical Activity International Society for Physical A and Health. The Toronto Charter for Physical Activity: A Global Call for Action. *J Phys Act Health*. 2010; 7 Suppl 3: S370-85.

7. Mendis S, Puska P and Norrving B. Global atlas on cardiovascular disease prevention and control. Geneva: World Health Organization, 2011.

8. Health Service Executive. Get Ireland Active! National Physical Activity Plan For Ireland. Dublin: Stationery Office, 2016.

9. Department of Health and Children. Changing Cardiovascular Health. National Cardiovascular Health Policy 2010-2019. Dublin: Stationery Office, 2010.

10. Murtagh EM, Nichols L, Mohammed MA, Holder R, Nevill AM and Murphy MH. The effect of walking on risk factors for cardiovascular disease: an updated systematic review and meta-analysis of randomised control trials. *Prev Med*. 2015; 72:34-43.

11. World Health Organization. Global Action Plan For The Prevention of Noncommunicable Diseases 2013-2020. Geneva: World Health Organization, 2013.

12. Department of Health. Healthy Ireland Survey 2016. Summary of Findings. Dublin: Stationery Office, 2016.

13. Katzmarzyk PT. Physical activity, sedentary behavior, and health: paradigm paralysis or paradigm shift? *Diabetes*. 2010; 59(11):2717-25.

14. Church TS, Thomas DM, Tudor-Locke C, et al. Trends over 5 decades in US occupation-related physical activity and their associations with obesity. *PloS One*. 2011; 6(5):e19657.

15. Waters CN, Ling EP, Chu AH, et al. Assessing and understanding sedentary behaviour in office-based working adults: a mixed-method approach. *BMC Public Health*. 2016; 16(1):360.

16. Owen N, Sparling PB, Healy GN, Dunstan DW and Matthews CE. Sedentary behavior: emerging evidence for a new health risk. *Mayo Clin Proc*. 2010; 85(2):1138-41.

17. Gibbs BB, Hergenroeder AL, Katzmarzyk PT, Lee IM and Jakicic JM. Definition, measurement, and health risks associated with sedentary behavior. *Med Sci Sports Exerc*. 2015; 47(6):1295-300.

18. Owen N, Healy GN, Matthews CE and Dunstan DW. Too much sitting: the population health science of sedentary behavior. *Exerc Sport Sci Rev*. 2010; 38(3):105-13.

19. Warren TY, Barry V, Hooker SP, Sui X, Church TS and Blair SN. Sedentary behaviors increase risk of cardiovascular disease mortality in men. *Med Sci Sports Exerc*. 2010; 42(5):879-85.

20. Biswas A, Oh PI, Faulkner GE, et al. Sedentary time and its association with risk for disease incidence, mortality, and hospitalization in adults: a systematic review and meta-analysis. *Ann Intern Med*. 2015; 162(2):123-32.

21. Thorp AA, Owen N, Neuhaus M and Dunstan DW. Sedentary behaviors and subsequent health outcomes in adults a systematic review of longitudinal studies, 1996-2011. *Am J Prev Med*. 2011; 41(2):207-15.

22. Chomistek AK, Manson JE, Stefanick ML, et al. Relationship of sedentary behavior and physical activity to incident cardiovascular disease: results from the Women's Health Initiative. *J Am Coll Cardiol*. 2013; 61(23):2346-54.

23. Wilmot EG, Edwardson CL, Achana FA, et al. Sedentary time in adults and the association with diabetes, cardiovascular disease and death: systematic review and meta-analysis. *Diabetologia*. 2012; 55:2895-905.

24. Morris JN, Heady, J.A., Raffle, P.A.B., Roberts, C. G. and Parks, J.W. Coronary heart disease and physical activity of work. *Lancet*. 1953; 262(6796):1111-20.

25. Alavi SS, Makarem, J., Mehrdad, R. and Abbasi, M. Metabolic Syndrome: A Common Problem among Office Workers. *International Journal of Occupational and Environmental Medicine*. 2015; 6(1):492-34.

26. Katzmarzyk PT, Church TS, Craig CL and Bouchard C. Sitting time and mortality from all causes, cardiovascular disease, and cancer. *Med Sci Sports Exerc*. 2009; 41(5):998-1005.

27. Dunstan DW, Barr EL, Healy GN, et al. Television viewing time and mortality: the Australian Diabetes, Obesity and Lifestyle Study (AusDiab). *Circulation*. 2010; 121(3):384-91.

28. Wijndaele K, Brage S, Besson H, et al. Television viewing time independently predicts all-cause and cardiovascular mortality: the EPIC Norfolk study. *Int J Epidemiol*. 2011; 40(1):150-9.

29. Moreno-Franco B, Penalvo, J.L., Andrés-Esteban, E.M., Malo, S., Lallana, M.J., Casasnovas, J.A. and León-Latre, M. Association between daily sitting time and prevalent metabolic syndrome in an adult working population: the AWHS cohort. *Nutrición Hospitalaria*. 2015; 32(6):2692-700.

30. Central Statistics Office. Vital Statistics: Yearly Summary. Dublin: Stationery Office, 2016.

31. Smyth B, Marsden P, Donohue F, et al. Planning for Health: Trends and Priorities to Inform Health Service Planning 2017. Dublin: Health Service Executive, 2017.

32. Kazi A, Duncan M, Clemes S and Haslam C. A survey of sitting time among UK employees. *Occupational Medicine*. 2014; 64(7):497-502.

33. Buckley JP, Hedge A, Yates T, et al. The sedentary office: an expert statement on the growing case for change towards better health and productivity. *Br J Sports Med*. 2015; 49:1357-62.

34. Jans MP, Proper KI and Hildebrandt VH. Sedentary behavior in Dutch workers: differences between occupations and business sectors. *Am J Prev Med*. 2007; 33(6):450-4.

35. Das BM, Mailey E, Murray K, Phillips SM, Torres C and King AC. From sedentary to active: Shifting the movement paradigm in workplaces. *Work*. 2016; 54(2):481-7.

36. Chu AH, Ng SH, Tan CS, Win AM, Koh D and Muller-Riemenschneider F. A systematic review and meta-analysis of workplace intervention strategies to reduce sedentary time in white-collar workers. *Obes Rev*. 2016; 17(5):467-81.

37. Addley K, McQuillan P and Ruddle M. Creating healthy workplaces in Northern Ireland: evaluation of a lifestyle and physical activity assessment programme. *Occupational Medicine*. 2001; 51(7):439-49.

38. Murphy MH, Murtagh EM, Boreham CA, et al. The effect of a worksite based walking programme on cardiovascular risk in previously sedentary civil servants [NCT00284479]. *BMC Public Health*. 2006; 6(1):136.

39. Dallat MA, Hunter RF, Tully MA, Cairns KJ and Kee F. A lesson in business: cost-effectiveness analysis of a novel financial incentive intervention for increasing physical activity in the workplace. *BMC Public Health*. 2013; 13(1):953.

40. Mair JL, Boreham CA, Ditroilo M, McKeown D, M Lowery M, Caulfield B, Vito G. Benefits of a worksite or home-based bench stepping intervention for sedentary middle-aged adults–a pilot study. *Clin Physiol Funct Imaging*. 2014; 34(1):10-7.

41. Dugdill L, Brettle A, Hulme C, McCluskey S and Long A. Workplace physical activity interventions: a systematic review. *International Journal of Workplace Health Management*. 2008; 1(1):20-40.

42. Malik SH, Blake H and Suggs LS. A systematic review of workplace health promotion interventions for increasing physical activity. *Br J Health Psychol*. 2014; 19(1):149-80.

43. Gilson ND, Puig-Ribera A, McKenna J, Brown WJ, Burton NW and Cooke CB. Do walking strategies to increase physical activity reduce reported sitting in workplaces: a randomized control trial. *Int J Behav Nutr Phys Act*. 2009; 6(1):43.

44. Penderson SJ, Kitic CM, Bird ML, et al. Is self-reporting workplace activity worthwhile? Validity and reliability of occupational sitting and physical activity questionnaire in desk-based workers. *BMC public health*. 2016; 16(1):836.

45. Kader P. Nursing research principles, process and issues. New York: Palgrave Macmillan, 2006.

46. Hickson M. Research handbook for health care professionals. Oxford: John Wiley & Sons, 2013.

47. Craig CL, Marshall AL, Sjostrom M, et al. International physical activity questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc*. 2003; 35(8):1381-95.

48. Edwardson CL, Winkler EA, Bodicoat DH, et al. Considerations when using the activPAL monitor in field-based research with adult populations. *Journal of Sport and Health Science*. 2016. Available from: https://doi.org/10.1016/j.jshs.2016.02.002 (accessed 6 February 2017).

49. IPAQ Research Committee. Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ)–short and long forms. Available from: http://www.institutferran.org/documentos/scoring_short_ipaq_april04.pdf (2004, accessed 5 February 2017).

50. Morgan K, McGee H, Watson D, et al. SLAN 2007: survey of lifestyle, attitudes and nutrition in Ireland: main report. Dublin: Department of Health and Children, 2008.

51. Kaminsky LA, Ozemek C. A comparison of the Actigraph GT1M and GT3X accelerometers under standardized and free-living conditions. *Physiological measurement*. 2012; 33(11):1869.

52. Central Statistics Office. Women and Men in Ireland 2013. Dublin: Stationery Office, 2014.

53. Chastin SF, Culhane B, Dall PM. Comparison of self-reported measure of sitting time (IPAQ) with objective measurement (activPAL). *Physiological measurement*. 2014; 35(11):2319.

54. Yap TL, James DM. Tailored e-mails in the workplace: A focus group analysis. *AAOHN Journal*. 2010; 58(10):425-32.

55. Castillo-Retamal M, Hinckson EA. Measuring physical activity and sedentary behaviour at work: a review. *Work*. 2011; 40(4):345-57.

56. World Health Organization. Global recommendations on Physical Activity for health. Geneva: World Health Organization, 2010.

57. de Munter JS, van Valkengoed IG, Agyemang C, et al. Large ethnic variations in recommended physical activity according to activity domains in amsterdam, the netherlands. *Int J Behav Nutr Phys Act*. 2010; 7(1):85.

58. van Poppel MN, Chinapaw MJ, Mokkink LB, et al. Physical activity questionnaires for adults: a systematic review of measurement properties. *Sports Med*. 2010; 40(7):565-600.

59. Cerin E, Cain KL, Oyeyemi AL, et al. Correlates of agreement between accelerometry and self-reported physical activity. *Medicine and Science in Sports and Exercise*. 2016; 48(6):1075-84.

60. Lee PH, Macfarlane DJ, Lam TH, et al. Validity of the International Physical Activity Questionnaire Short Form (IPAQ-SF): a systematic review. *Int J Behav Nutr Phys Act*. 2011; 8(1):115.

61. Urda JL, Lynn JS, Gorman A, Larouere B. Effects of a minimal workplace intervention to reduce sedentary behaviors and improve perceived wellness in middle-aged women office workers. *Journal of Physical Activity and Health*. 2016; 13(8):838-44.

Appendix 1

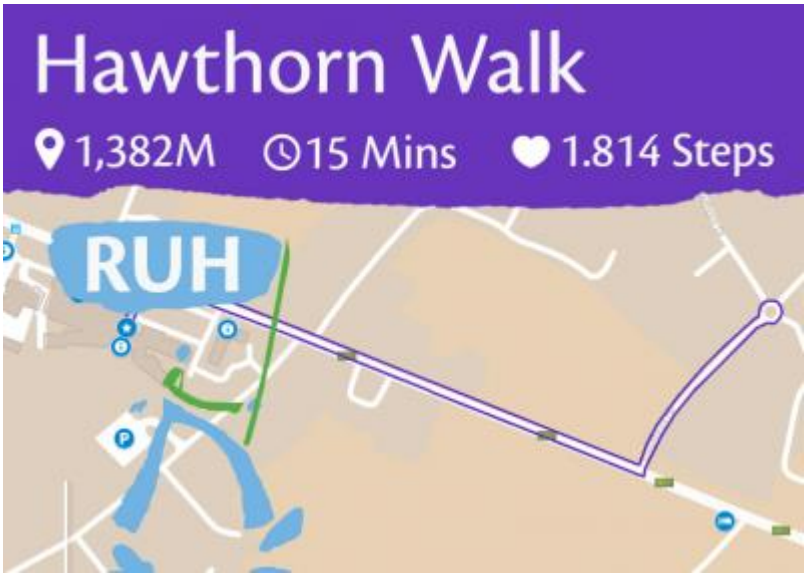
HOSPITAL WALKS

Website link: http://www.hospitalwalks.com/hospital-walks/ruh-walks/

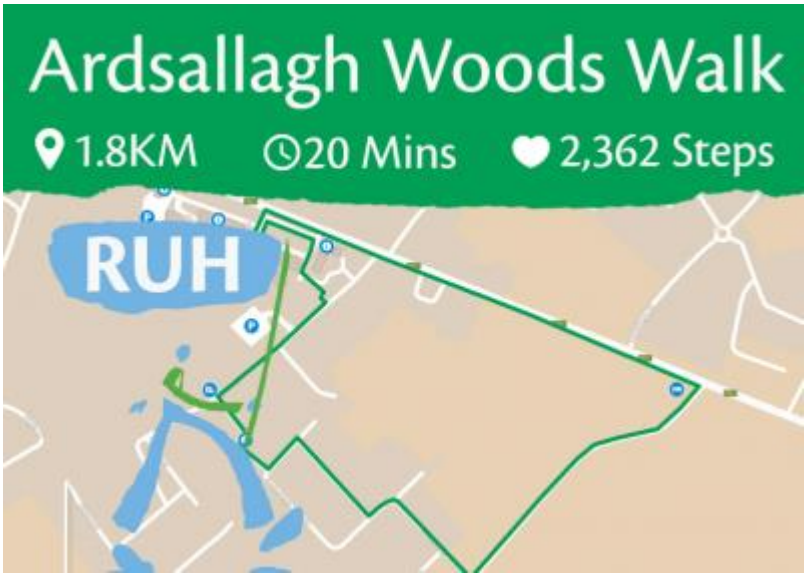
Roscommon University Hospital Walks

RUH: Town Slí Walk

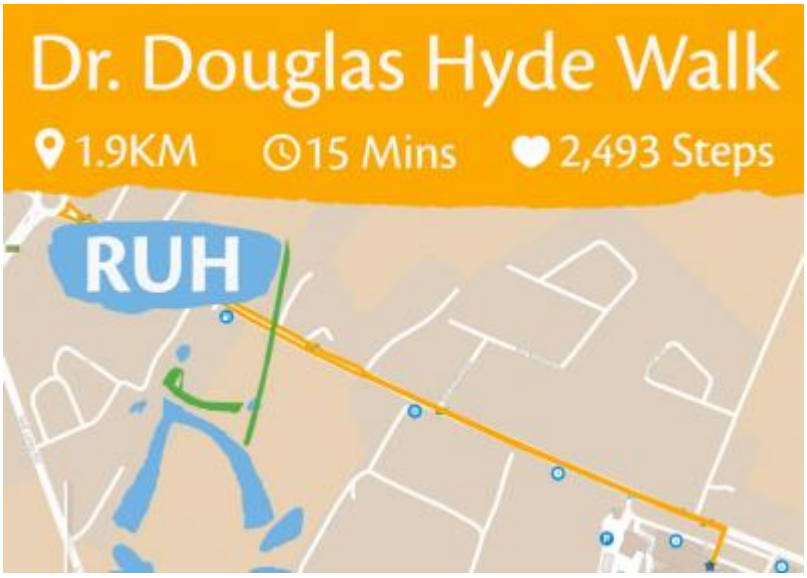
RUH: Golf Course Slí Walk



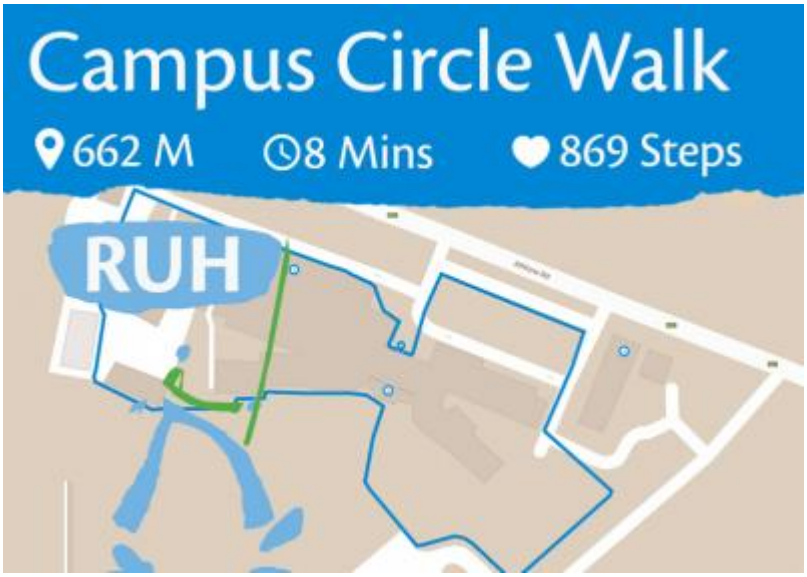
RUH: Hawthorn Walk



RUH: Ardsallagh Woods Walk



RUH: Dr. Douglas Hyde Walk



RUH: Campus Circle Walk