Is Sedentary Behaviour Or Physical Activity Associated With Loneliness In Older Adults? Results Of The European-Wide SITLESS Study.

Abstract

Research found that social relationships are central to the health and well-being of an ageing population. Evidence exploring the association between physical activity (PA) and sedentary behaviour (SB) with social isolation and loneliness is limited. This study uses objectively measured PA and SB (ActiGraph®) and self-reported measures of loneliness (DeJong Gierveld Loneliness Scale-DGLS-6) and social engagement (Lubben Social Network Scale-LSNS-6) from a European-wide study of community-dwelling older adults from the SITLESS study. Social isolation was associated with SB where higher levels of SB were associated with an increased the level of social isolation, controlling for age, sex, living arrangements, employment status, BMI, educational background, marital status and self-reported general health. In contrast, PA was not associated with social isolation, and neither SB or PA were statistically significant predictors of loneliness. SB may be linked to social isolation in older adults, but PA or SB are not necessarily linked to loneliness in older community-dwelling adults.

Key words

Moderate-Vigorous physical activity; Light physical activity; Objective physical activity; social isolation.

Introduction

A decrease in economic resources, an increase in mobility impairment, or a loss of family and friends can increase the risk of social isolation - the quantitative measure of social relationships and contacts (Nicholson, 2012; Victor, 2011), which then can lead to loneliness - the subjective feeling regarding the discrepancy between desired and actual social relationships (Shvedko et al., 2018; Steptoe et al., 2013) in older adults. Statistics suggest that one in fourteen people (7%) experience social isolation across Europe. In the UK, it is estimated that one third of older adults (≥65 years) will experience loneliness. This is important as the proportion of older adults is expected to grow by 50% by 2025, resulting in an increased proportion suffering social isolation and loneliness (Age UK, 2018; Bernard, 2013).

Research has demonstrated that loneliness and social isolation are associated with negative consequences on health and well-being especially for older adults (Cacioppo & Cacioppo, 2014; Holt-Lunstad et al., 2010). Individuals who are socially isolated and lonely are at increased risk of chronic diseases (Lauder et al., 2006; Senez et al., 2004; Shankar et al., 2011; Thurston & Kubzanskv, 2009); cognitive impairment (Pitkala et al., 2011); and all-cause mortality (Elovanio et al., 2017; Patterson & Veensta, 2010; Newall et al., 2013). Furthermore, both are linked with potential modifiable negative health behaviours such as poor nutritional intake (Ferry et al., 2005) and low physical activity (PA) levels (Hawkley et al., 2009). It is estimated that the social and healthcare benefits of addressing loneliness in the UK are approximately £900 per person per annum (Bernard, 2013), and so interventions to address this growing public health concern are warranted.

The health benefits of PA in older adults are well established (Bangsbo et al., 2019). There is also evidence for the independent health benefits of reducing prolonged sedentary behaviour (SB) (Dogra & Stathokostas, 2012; WHO, 2014; Willmott et al., 2012). Evidence suggests that PA may have an important role for loneliness and social isolation through social, psychological, and biological mechanisms. For example, PA increases social networking during group activities which can

compensate for the loss of meaningful social relationships (Ferraro & Farmer, 1995). PA also generates positive emotions and feelings of well-being (Cohen & Wills, 1985; Newhall et. al., 2013) as well as a sense of identification and social attraction to others engaged in the same activities (Henry et al., 1999) which removes the barriers to social interaction and reduces loneliness (Lubans et al., 2016; Milligan et al., 2013). However, evidence supporting the efficacy of interventions to reduce SB with social isolation and loneliness whilst emerging (Schrempt et al., 2019) is limited yet (Dicken et al., 2011; Pels & Kleinert, 2016; Schvedko et al., 2018).

Results from existing research exploring the nature of the relationship between PA, SB, social isolation and/or loneliness may still suffer some bias. Firstly, many studies appear to recruit from clinical or senior centre settings which promote or encourage social interaction, and so may potentially fall short of reaching especially socially isolated community-dwelling older adults (Pels & Kleinert, 2016; Robins et al., 2016; Shvedko et al., 2018). Additionally, the use of objective PA measures such as accelerometery is growing and provide a more accurate measure of overall PA levels as well as an understanding of PA intensity required to elicit associated benefits (Doherty et al., 2017: UK Biobank study; n=106,053 participants), but self-reported measures are still more widely used (Pels & Kleinert, 2016). Also, those studies that have included an objective measure of PA include PA as a secondary outcome or combined with an additional measure (Schvedko et al., 2018). As a result, the true effect of PA and SB is limited.

Consequently, this study aims to understand the relationship between PA and SB with loneliness and social isolation. It considers community-dwelling older adults instead of those in senior centres and considers SB as well as PA using objective measures that provide a more accurate summary of PA level and intensity. Based on these premises, this study aims to bring new insights to the understanding of the association between PA and loneliness and social engagement in older adults.

Method

Participants

This cross-sectional analysis is based on the SITLESS study, which is a prospective cohort study of community-dwelling men and women aged ≥65 years from across Denmark, Spain, Germany and the United Kingdom. Participants were eligible if they were able to walk for ≥2 min (with or without a walking aid); scored four or above on the Short Physical Performance Battery (SPPB); carried out regular physical activity (PA) ≤30 minutes on 5 days per week, where PA is activity that causes breathlessness and excludes regular walking (e.g. jogging or cycling); and/or spend 6–8 hours per day sitting e.g. watching TV or working at the computer. Participants were excluded if they had three or more errors on a six-item cognitive impairment questionnaire to identify moderate or severe dementia; had a medical condition which interfered with the study design, suffered from unstable medical conditions (e.g. elevated blood pressure after medication, uncontrolled hypertension) or symptomatic cardiovascular diseases that contraindicates participation in PA; could not commit to attend 75% of the exercise referral scheme (ERS) sessions throughout the intervention; and/or had participated in an ERS in the six months prior to their entry into the study. A total of 2,660 older adults were recruited across the four countries via media (letters and social media), general practitioners and other health professionals from primary care, and senior centre community groups. Of those, 45.15% did not participate in the study (27.3% of those were excluded based on eligibility assessment). A total of 1,360 older adults provided baseline data. Further details can be found in the study protocol (Giné-Garriga et al., 2017). SITLESS has been approved by the various Ethics and Research Committees of each intervention site. Participation was voluntary and all participants provided informed consent before the start of the study.

Assessment of Physical Activity (PA) and Sedentary Behaviour (SB)

All participants were asked to wear an accelerometer (ActiGraph GT3X+; Actigraph, LLC, Pensacola, FL) on their dominant hip during waking hours for seven consecutive days and were told to remove

them during any water-based activities such as bathing or swimming, and during sleep time. The devices were initialized to collect data using 10-second epochs. Non-wear time was defined using the Choi, Liu, Matthews, & Buchowski (2011) algorithm which uses a 2-window system; a 90-minute window for checking for consecutive zero counts and another 30-minute up- and down- stream window for checking for more than 2 minutes of non-zero counts (Choi et al., 2011). The study included the results from participants with at least four valid days including at least one weekend day; to be included each day had to include at least 600 minutes (10h/day) of wear time as in previous studies (Migueles et al., 2017). SB was classified as <100 counts per minute (CPM), daily light physical activity (LPA) was 100-2019 CPM, and daily moderate-physical activity (MVPA) was >2020 CPM. Step counts were also included. Values are the average daily time spent in SB, LPA and MVPA.

This study uses MVPA and LPA measured objectively using an ActiGraph® during waking hours only over a one-week period at baseline. SB is also used and is measured objectively as average daily sitting time and the number of minutes spent in activities requiring ≤1.5 MET using a hip worn ActiGraph® accelerometer.

Assessment of Social isolation and loneliness

Social isolation was evaluated using a structured interview including the Lubben Social Network Scale (LSNS-6) with an internal consistency rating (ICC) of 0.55-0.66 (Lubben & Gironda, 2004; Rutledge et al. 2003). It is a 6-item scale that gauges the level of social isolation using the number and frequency of social contact with friends and family and the perceived social support from these sources. Scores range from 0 to 30 where a score of ≤12 delineates “at-risk” for social isolation.

Loneliness was evaluated using the DeJong Gierveld Loneliness Scale (DGLS-6) with an ICC of 0.85-0.95 in older adults (De Jong Gierveld & Van Tilburg, 2010). It is a 6-item scale providing an overall measure of loneliness that combines ‘emotional loneliness’, when someone misses an intimate relationship, and ‘social loneliness’, when someone misses a wider social network. Scores range from 0 to 6 where 0 is ‘least lonely’ and 6 is ‘most lonely’.

Assessment of covariates

Research suggests that there are a number of risk factors for loneliness and social isolation (Schrempft et al., 2019; Shvedko et al., 2018) and so socio-demographic covariates of age (years), sex (male/female), marital status (single, married, widowed, divorced), living arrangements (alone, spouse/partner, son/daughter, other relative, other family, or non-relatives), employment status (employed, unemployed), BMI (underweight, normal weight, over-weight, obese), and education (can read/write, cannot read/write, primary, secondary, university) were included. Additionally, self-rated health status (SF-12) (1 is excellent, 2 is very good, 3 is good, 4 is fair, and 5 is poor); and physical function (Short Physical Performance Battery, SPPB), a group of measures that combines the results of the gait speed, chair stand and balance tests (Guralnik et al., 2000) where scores range from 0 (worst performance) to 12 (best performance) were included in the analysis.

Statistical analysis

Firstly, data was assumed to be missing at random and considering the level of missing data of 5-6% in the variables of LSNS-6, DGLS-6, MVPA, SB, and LPA (Table 1), multi-imputation was applied using an Expectation Maximisation approach in SPSS (v.25). Regression analysis was then carried out. A multilevel linear regression to address clustering by couples and countries was used to predict social isolation (LSNS-6) i) SB; ii) SB and MVPA; iii) SB, MVPA and LPA; iv) SB, MVPA, LPA and age, sex, marital status, living arrangements, employment status, BMI, education, self-rated health status (SF-12) and physical function (Short Physical Performance Battery, SPPB).

The assumptions of normality was violated by the Loneliness (DGLS-6) measure and also considering the ordinal nature of the dependent variable of loneliness (DGLS-6 at six levels ranging from (1) no social isolation to (6) severe social isolation), an ordinal logistics regression using the proportional odds model as a measure of association between SB, MVPA and LPA and loneliness was calculated (Abreu et al., 2008). SB, MVPA, LPA and age, sex, marital status, living arrangements, employment

status, BMI, education, self-rated health status (SF-12), and physical function (Short Physical Performance Battery, SPPB) were included in the model.

Results

A total of 1360 participants completed the baseline interview-based, self-reported survey and functional tests. The number of participants, the response mean (standard deviation), and range of responses are reported in **Table 1**. The mean age of the sample was 75.27 (St. dev=6.29) years; 62% were female, 75% had a secondary education or above, 78% were overweight or obese, 53% were married/in a stable relationship, 52% were living with a husband/wife or partner; 69% experienced good-to-excellent health.

The mean social isolation score (LSNS-6) (16.63) and loneliness score (DGLS-6) (2.16) indicated that the sample was at low risk of social isolation and loneliness. Daily MVPA was 23.73 (19.99) minutes, daily SB 160.28 (52.69) minutes, and daily LPA was 678.28 (76.01) minutes.

Physical activity and social isolation (LSNS-6)

The assumptions for linear regression were tested and met where data included no outliers and data was normally distributed. Consequently, a multiple linear regression was calculated using the LSNS-6 data **(Table 2)**. Separate multiple linear regressions, adjusted for socio-demographic characteristics, were developed to understand the association between SB, MVPA, LPA and social isolation (LSNS-6). Model 1 included the effects of MVPA on LSNS-6 and a significant regression equation was found ($F(1, 1278) = 5.18$, $p<0.05$). MVPA explained 10% of the variance in LSNS-6 ($R^2=0.1$); Model 2 included the effects of MVPA and SB on LSNS-6 and a significant regression equation was found ($F(2, 1277) = 5.97$, $p<0.05$). MVPA and SB explained 10% of the variance in LSNS-6 ($R^2=0.1$); Model 3 included the effects of MVPA, SB, and LPA on LSNS-6 and a significant regression equation was found ($F(3, 1276) = 6.04$, $p<0.001$). MVPA, SB and LPA explained 12% of the variance in LSNS-6 ($R^2=0.12$); Model 4 included MVPA, SB, LPA, and covariates of age, sex, living arrangements, employment status, BMI, educational

background, marital status. Self-reported general health, and physical function and a significant regression equation was found ($F (12, 1267) = 5.62$, $p<0.001$) where 23% of the variance was explained ($R^2= 0.23$).

The analysis of the final model (model 4) showed that SB ($\beta=0.01$, $t (1278) = 3.08$, $p<0.05$) was a significant independent predictor of social isolation measured using LSNS-6. Additionally, the covariates of sex ($\beta=-0.82$, $t (1278) = 2.17$, $p<0.05$); BMI ($\beta=0.77$, $t (1278) = 3.32$, $p<0.001$); physical function ($\beta=0.35$, $t (1278) = 3.97$, $p<0.001$); and self-reported general health ($\beta=-0.71$, $t (1278) = -3.28$, $p<0.001$) were also found to be statistically significant predictors of social isolation.

MVPA ($\beta=0.01$, $t (1278) = 1.29$, $p=0.20$); LPA ($\beta=0.02$, $t (1278) = 1.52$, $p=0.13$); age ($\beta=0.06$, $t (1278) = 1.73$, $p=0.08$); marital status ($\beta=-0.08$, $t (1278) = -0.38$, $p=0.71$); living arrangements ($\beta=0.32$, $t (1278) = 1.43$, $p=0.15$); educational background ($\beta=-0.17$, $t (1278) = -0.76$, $p=0.45$); and employment status ($\beta=0.82$, $t (1278) = 1.17$, $p=0.24$) were not found to be significant for social isolation.

Physical activity and loneliness (DGLS-6)

Using the DGLS-6 data, multicollinearity was examined using the variance inflation factor (VIF), and all variables had a VIF > 10, therefore no variables were considered for possible exclusion from the multivariable analysis (O'Brien, 2007). The assumption of proportional odds was rejected using the test of parallel lines ($p\leq0.000$) but as the number of variables (14) and sample size (1360) is large and also included continuous variables then this was not considered an issue (Allison, 1999; Brant, 1990). The Nagelkeke and McFadden measure (0.10) showed that the model is a reasonable predictor of loneliness for any particular individual by explaining 10% of the variation.

MVPA ($p=0.49$), SB ($p=0.44$), or LPA ($p=0.75$) were not significant predictors of loneliness. The following were significant predictors of loneliness where the odds of being lonely were almost the same across regardless of age (OR=0.98; (95% CI, 0.61 to 0.99); and where being female (OR=1.32; 95% CI, 1.04 to 1.68); living with non-relatives (OR=21.12; CI 95% 1.15 to 387.61); or being overweight

(OR=5.31;CI 95% 1.08 to 26,31) increased the odds of being lonely; and where being single (OR= 0.02; CI 95% 0.00 to 0.31), married (OR=0.01; CI 95% 0.00 to 0.2), divorced (OR=0.02; CI 95% 0.00 to 0.33); or healthy (OR=0.44; CI 95% 0.2 to 0,97) decreased the odds of feeling lonely (Table 3).

Discussion

Statement of findings

This study investigated the association between social isolation and loneliness, and objectively measured PA and SB in a sample of community dwelling older adult men and women, included in the SITLESS study. Social isolation measured using LSNS-6 was associated with SB where higher levels were associated with increased levels of social isolation, controlling for age, sex, living arrangements, employment status, BMI, educational background, marital status and self-reported general health. In contrast, PA intensity (MVPA, SB, or LPA) were not found to be significant predictors of loneliness measured using the DGLS-6. These findings suggest that SB behaviour may be associated with social isolation among older community-dwelling adults, but further research is needed to better understand the relationship between PA and loneliness.

Social Isolation

A substantial body of evidence demonstrates that social connectedness benefits health (Cacioppo & Cacioppo, 2014; Holt-Lunstad et al., 2010). Among older adults, social isolation has been associated with being physically inactive (Dickens et al. 2011) and the findings from the current cross-sectional study identified SB as a statistically significant independent predictor of social isolation. Social isolation was associated with more time spent in SB which support the findings presented in a recent study investigating the association between social isolation and objectively measured PA in community dwelling older adults (Schrempft et al. 2019). However, no association between MVPA and LPA with social isolation was found in our study which contrasts with the findings from Schrempft et al. (2019). The differences in findings may be due to the study population where the sample used in our study

were at low risk of social isolation and high risk of low PA. The effects may be stronger in a sample with a greater range of social integration and higher levels of PA. For example, greater social connectedness has been associated with being physically active, but older adults have demonstrated diminishing participation in recreational PA such as team sports and organised exercise groups (Robins et al. 2016). Furthermore, objective measures of PA do not provide details regarding the type of PA carried out, and research suggests that PA with a social component such as group activities can improve social isolation measures (Dickens et al., 2011). It may well be that the sample are involved in less social PA or perhaps their experience of PA is more individualistic, rather than social. A systematic review of the association of PA and quality of life in older adults demonstrated a link between PA and the quality of life domain for social functioning, prompting further investigation (Vegetti *et al*. 2014). Future research tackling social isolation may also be a target to reduce SB and increase PA among community-dwelling older adults and should focus on PA interventions that consider the functionality of older adults and include a social activity.

Loneliness

Theories have been developed that posit causal mechanisms between PA and loneliness. For example, the social compensation model proposes that engaging in PA can compensate for the loss of social connections that older adults experience, through the networks developed during exercise (Ferraro & Farmer, 1995). However, in keeping with a previous analysis of the relationship between objectively measured PA and loneliness (Schrempft et al., 2019), our findings have not confirmed this theory. This may be because the use of objective measures of PA provide a measure of overall activity and do not allow for the comparison of different types of exercise (group exercise, active travel, domestic physical activity, outdoor recreation) with loneliness :(Rapp et al., 2018). It may be that most of the time spent in PA and SB are done alone, so new social networks are not formed. Future research should attempt to identify if group compared with individual exercise is associated with reduced loneliness in older adults.

Strengths and limitations

The cross-sectional nature of the study prevents causal conclusions from being drawn. It is possible that greater social isolation leads to reduced PA, but it is also possible that less physically active people withdraw from social contact and may be more likely to become lonely. Additionally, the measures of social isolation and loneliness were secondary outcomes. Nonetheless, PA can improve psychosocial outcomes, so it is still important to explore the association between PA and social health to inform future interventions focusing specifically on loneliness and PA.

The measure of social isolation was comprehensive in that it considered contacts with friends and family, but it did not consider the impact of social network size. Also, the DGLS-6 measure of loneliness contained three questions relating to social isolation and three relating to loneliness and therefore may not be a sensitive measure of overall loneliness. Furthermore, the majority of adults within this study were at low risk of social isolation and loneliness, inactive (e.g. ≤30 minutes of activity 5 days a week that made them breathless), and overweight or obese (78%), so results may be biased. Future research should explore how the magnitude of the social network might impact on social isolation and explore the subscales of emotional and social loneliness provided by the DGLS-6 measure or a different measure of loneliness. Additionally, the measures used within our study are limited to those available from the SITLESS study and so future studies should also consider including other covariates such as pain (Smith et al., 2019). Furthermore, the SITLESS study includes data from Denmark, Spain, Germany and the United Kingdom, and future research should explore how cultural differences might affect the results.

Despite the limitations of this study, to the authors' knowledge, it is one of a few to assess the association of PA and SB on loneliness and social isolation, and specifically to target a community-dwelling older adult population aged 65 years and over, using objective measures of PA and SB (Schrempft et al., 2019; Schvedko et al., 2018). This study measured PA and SB using an accelerometer-based measure of activity rather than self-report in order to provide objective evidence of links with

social isolation and loneliness. Self-report measures are more commonly used in observational epidemiology studies exploring PA and health outcomes. However, bias caused by social desirability, or problems in recall can limit the accuracy of self-reports in older adults (Dyrstad et al., 2014; Murphy, 2009; Saelens et al., 2012; Shepherd, 2003). Furthermore, inaccuracy of self-reported PA may be more exaggerated among older adults because of recall error, and because most activity is accumulated through light intensity everyday living activities such as gardening, housework or shopping, rather than specific exercise that is planned, structured and defined such as jogging or weight training (Dyrstad et al., 2014; Murphy, 2009; Saelens et al., 2012). Consequently, the results from this study provide a more accurate reflection of the actual PA carried out by older adults in a community setting. These findings suggest that SB may be linked to social isolation in older adults, but that PA or SB are not necessarily linked to loneliness in older community-dwelling adults. Consequently, the key message from this study is in line with current public health policy which suggests that sitting less and moving more is beneficial to health in older adults. Future interventions should target sitting behaviour by including social components within the intervention such as group activities. Additionally, consideration should be given to tailoring the interventions to address functionality and capability limitations that may prevent older adults from engaging in PA and as a result address both loneliness and social isolation.

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