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The association of resilience and physical activity in older adults: cross-sectional analyses from the NICOLA study

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Abstract

Aim As more of the world's population are living longer, supporting the mental and physical health of older adults is becoming increasingly important in public health. Resilience is a dynamic process encompassing positive adaptation in the face of adverse experiences that would otherwise lead to poor outcomes. The aim of the study is to explore the association between physical activity and resilience in older adults.

Subject and methods The data used in this study was taken from the results of the Self Completed Questionnaires and Computer Assisted Personal Interviews from the Northern Ireland Cohort for the Longitudinal Study of Ageing. A secondary analysis was conducted on a sample of 4040 participants to examine the association between resilience (Brief Resilience Scale) and on moderate/vigorous physical activity (International Physical Activity Questionnaire – Short Form) through chi-square and Mann–Whitney U tests and an ordinal regression being conducted.

Results Data was included for 4040 participants, of whom 90% did not meet the recommended moderate physical activity guidelines. The findings of this study indicated that higher resilience levels are associated with higher levels of moderate and vigorous physical activity levels.

Conclusion Worryingly, a large percentage of the older adult population are not sufficiently active and this is something that needs to be addressed. The findings suggest that with these low levels of physical activity, interventions should be created to target this population.

Keywords Resilience · Physical activity · Northern Ireland · Cross-sectional · Older adults

Introduction

In modern society, a greater proportion of the world's population are living longer. It is anticipated that by 2050, of one in four people will be over the age of 65 years old (United Nations 2022). As the population ages, quality of life, mental health, physical health and well-being become important public, societal, and economic considerations. Evidence suggests that these elements can all be influenced by sedentary behaviour and physical activity, with increased sedentary behaviour and physical inactivity leading to increased risk of mortality and

non-communicable diseases (Katzmarzyk et al. 2022; World Health Organisation 2022a; Sheppard 2021; Thivel et al. 2018; Cecchini et al. 2010). In the older adult population, sedentary behaviour often increases, while with physical inactivity rising due to more time spent sitting at home, increased use of technology and TV viewing, retirement or occupational changes, changes in family or living circumstances (Hall et al. 2021; Wilson Leung et al. 2021; Lewis et al. 2017; Harvey et al. 2013), there are many factors which impact ageing, making it a complex construct (Merchant et al. 2022).

In the UK, it is estimated that 29% of older adults (65–74 years old) are not meeting the recommended levels of physical activity (Age UK 2019); in Northern Ireland, only 34% and 24% of older adults males and females are meeting these recommended guidelines (World Health Organization 2016). The World Health Organisation (2022b) recommend that older adults should undertake in regular daily physical activity involving at least 150–300 min of

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moderate activity or 75–150 min of vigorous activity per week. As levels of inactivity rise, health-care expenses and economic concerns grow (World Health Organisation 2022a; Kolu et al. 2022; Hall et al. 2021; Ding et al. 2016).

A review of reviews by Cunningham et al. (2020) highlighted that regular physical activity acts as a protective factor against serious physical and mental health issues, cognitive decline, and brain diseases (e.g., Alzheimer's, dementia), but noted that many older adults are not currently sufficiently physically active. This reduction of severe health conditions (McPhee et al. 2016; Taylor 2014) may lower health care expenses over time (Su et al. 2020; MCPhee et al. 2016). Another review conducted by Sun et al. (2013) also previously reported that older adults were less likely to engage in the recommended physical activity levels. A study by Remón et al. (2020) reported that across the EU the percentage of sufficiently active older people is low. Previous research has indicated that personal factors, physical and mental health issues, fragility, low income, environment/locale restrictions, and lifestyle and support issues could all impact one's level of physical activity (Bantham et al. 2021; Moschny et al. 2011; Chen 2010; King and King 2010; Rasinaho et al. 2007).

One aspect of mental health that is understudied within the older adult population is resilience. Known as a multidimensional complex concept, resilience has been associated with several definitions. Often it is acknowledged that resilience can be defined as "a dynamic process encompassing positive adaptation in the face of adverse experiences that would otherwise lead to poor outcomes" (Wainwright et al. 2019, p.164). Another definition of resilience is "the ability to be happy, successful etc. again, after something difficult or bad has happened" (Cambridge Dictionary 2022). Research suggests that resilience can reduce the adverse effects that stress puts on the body (Dagnino-Subiabre 2022; Dantzer et al. 2018; Mayo Clinic n.d.). This is particularly important, as in older adults a single stressor can result in many outcomes being impacted, for example bedrest impacting muscle wastage (Merchant et al. 2022).

The multifaceted construct of resilience often consists of two categories, physical and psychological. These categories can be influenced by a multitude of protective and risk factors highlighted by Merchant et al. (2022) as the "purpose of life". This, for example, involves perceived health, restrictions in mobility, exercise, environment, locus of control, cognitive functioning, mental and physical health, and socialization etc. Resilience is often associated with the following outcomes: social support longevity, high mobility, independence, connectedness, successful ageing, physical activity, locus of control, immunity, mental health, quality of life, and wellbeing (Dantzer et al. 2018; Musich et al. 2022a, b; MacLeod et al. 2016; Merchant et al. 2022).

Research indicates that physical activity and resilience are associated (Zach et al. 2021; Kukihara et al. 2018; Deuster and Silverman 2013). The construct of resilience and its association with physical activity is important as the population ages; these two elements can be considered essential for long-term health benefits. Evidence suggests that physical activity can improve resilience (Ávila et al. 2021; Deuster and Silverman 2013) which may directly lead to better quality of life and better levels of daily activity. Most studies of resilience focus on adolescents or college students (Belcher et al. 2021; Chow and Choi 2019; Galante et al. 2018; Ho et al. 2015), yet resilience is an important factor in all age groups, which is why research into aging and resilience is important, especially as resilience may support longevity. Within the older adult population, the literature particularly in the UK is scarce, and therefore the aim of this research is to explore the association between physical activity (moderate and vigorous levels) and resilience in older adults. We hypothesize that those with higher resilience are more likely to take part in more days of physical activity than those who have lower resilience. This study is unique, as it is the first in Northern Ireland to explore this area for older adults. The aim of this research is to inform future research involving physical activity and resilience in regard to public health promotion strategies.

Methods

Study population

This study uses the WAVE 1 data (collected between Feb 2014 and Mar 2016) from the ongoing NICOLA study, a longitudinal study involving men and women aged 50 years old ($n=8,478$) and exploring why and how certain social, economic, and biological factors are impacting the lives of older adults. The NICOLA study was designed to coincide with the TILDA study (Irish Longitudinal Study of Ageing) and the ELSA study (English Longitudinal Study of Ageing). Participation in the NICOLA study was voluntary, with participants chosen at random through a GP register or the Pointer address database in Northern Ireland. Consent for the study was obtained from all study participants before the commencement of the research, and ethical approval was obtained by the School of Medicine, Dentistry, and Biomedical Sciences Ethics Committee, Queen's University Belfast (SREC 12/23) and in accordance with the Helsinki Declaration. Further detail on the sampling strategy employed in the NICOLA study can be found in a previously published article (Neville et al. 2023) and report online: <https://www.qub.ac.uk/sites/NICOLA/> (accessed on 2 March 2023). Using WAVE 1 data, a cross-sectional study was carried out on older adults to examine physical activity and resilience, as

these were used only in WAVE 1. All participant data were given a unique code so that the data remained anonymous. This secondary data analysis study will only contain the data for adults aged 65 years and older from the NICOLA study ($n = 4040$).

Data collection

The data used in this study was taken from the results of the Self Completed Questionnaires and Computer Assisted Personal Interviews (CAPI) from the NICOLA study. Details of NICOLA study assessments can be found online at <https://www.qub.ac.uk/sites/NICOLA/> (accessed on 2 March 2023).

Socio-demographics This questionnaire measured general social demographics such as gender (male or female), age (65 years and older), education, and marital status, while also examining elements of physical activity (moderate or vigorous physical activity), lifestyle factors (smoking and drinking status etc.).

Physical activity Within this study we focus on physical activity components from the NICOLA study, which focused on two items from the International Physical Activity Questionnaire IPAQ – Short Form (Craig et al. 2003). These items included moderate physical activity (such as carrying light loads, bicycling at a regular pace, or doubles tennis. Do not include walking) or vigorous physical activity (such as heavy lifting, digging, aerobics, or fast bicycling) during the last 7 days.

Brief Resilience Scale (BRS) The BRS is a six-item scale used to measure resilience (Smith et al. 2008). Respondents indicate the extent to which they agree with each on a Likert scale from 1 (strongly disagree) to 5 (strongly agree). Items 1, 3, 5 are positively worded, while items 2, 4, 6 are negatively worded. The BRS is scored by reverse coding items 2, 4, and 6, the responses are summed and divided by the number of questions answered. Internal consistency of the scale has been previously reported as good, with Cronbach's alpha ranging from 0.80–0.91 (Smith et al. 2008). In this study the Cronbach's alpha was 0.86.

Data analysis

The data presented in this study is based on a secondary data analysis of the NICOLA data ($n = 8478$). The data was reviewed and any participant under the age of 65 was removed from the analysis ($n = 4380$). Additionally, respondents who did not answer the physical activity item were removed from the dataset ($n = 58$). This left a final sample of 4040 participants to examine the association between resilience (BRS) and moderate/vigorous physical activity.

All statistical analysis was conducted on SPSS (IBM SPSS Software, Version 28: IBM Corp., Armonk, NY, USA). The physical activity variables were recoded in binary variables 0 (not sufficiently active) and 1 (sufficiently active as per the current international physical activity guidelines). Meeting sufficient vigorous physical activity is specified as meeting at least 75 min of vigorous-intensity physical activity weekly, while meeting moderate physical activity is specified as meeting at least 150 min of moderate-intensity physical activity a week. The BRS scale was recoded into three tertiles of resilience: 1 'low', 2 'normal' and 3 'high' according to the BRS score.

Descriptive statistics for variables were reported for the sample, with variables being categorical and reported in frequencies and percentages. As data was not normally distributed ($p < 0.05$), a chi-square test was conducted to explore the differences between the three categorical variables for levels of resilience and days of moderately or vigorously partaking in physical activity. Additional subgroup analysis was examined with age and gender using a chi-square test. Cramer's V-test was used alongside the chi-square test to examine the association between the categorical variables as the effect size, in this study, small = 0.07, medium = 0.21, and larger = 0.35. A Mann–Whitney test was used to compare the difference between those sufficiently active and those not, in terms of mean resilience scores.

An ordinal logistic regression was used to examine the levels of resilience on physical activity levels with covariates of age and gender. For the secondary data analysis, the cross-sectional results of the ordinal regression are reported as odds ratios with 95% confidence intervals, which can be interpreted as the increase in the odds of higher resilience associated with increase moderate or vigorous physical activity levels. The significance level was assessed as a p -value of < 0.05 being considered statistically significant. Details of the NICOLA study dataset can be found online at <https://www.qub.ac.uk/sites/NICOLA/> (accessed on 2 March 2023), with access to the data available by application through <https://www.qub.ac.uk/sites/NICOLA/InformationforResearchers> accessed on 2 March 2023).

Results

Descriptive statistics regarding the sociodemographic and study characteristics of the study sample are shown in Table 1. The table shows that over half the sample were female (53.1%) and a majority were aged between 65 and <85 years old (91.6%). Two thirds of the sample were married or living as married (59.2%), with over a third having achieved the education level of primary school (33.2%) or GCSE/Intermediate/Junior/Group certificate or equivalent

Table 1 Socio-demographic and outcome variables of sample ($n = 4,040$)

	Overall N (%)
Gender	
Male	1894 (46.9)
Female	2146 (53.1)
Age	
65 to < 85 years old	3699 (91.6)
85 years and older	314 (8.4)
Smoking status	
Current	524 (13.0)
Ex	1546 (38.3)
Never	1964 (48.6)
Refused	6 (0.1)
Drinking status	
Current	2038 (50.4)
Ex	893 (22.1)
Never	1102 (27.3)
Refused	7 (0.2)
Marital status	
Married or living as married	2391 (59.2)
Single	382 (9.5)
Separated, divorced or widowed	1267 (31.4)
Education level	
Primary or some primary	1343 (33.2)
GCSE/Intermediate/Junior/group certificate or equivalent	1296 (32.1)
A-level/Leaving certificate or equivalent	289 (7.2)
Diploma/certificate	460 (11.4)
Primary degree	247 (6.1)
Postgraduate/higher degree	228 (5.6)
None/refused	177 (4.4)
Resilience (BRS)	
Low resilience	723 (17.9)
Normal resilience	2976 (73.7)
High resilience	341 (8.4)

(32.1%). The majority of the sample reported normal resilience levels (73.7%).

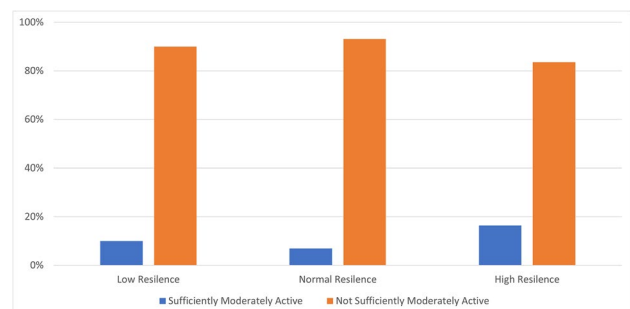
The majority of participants took part in no moderate physical activity (70.0%), with only 10.0% meeting the sufficient recommended guidelines (Table 2). Similarly, 86.1% of the sample had done no vigorous physical activity over the previous 7 days, with only 3.5% physically active. Overall, the mean BRS score was 3.53 (SD 0.74). Individuals who were not sufficiently moderately active had a lower mean BRS score of 3.51 (SD 0.74), compared to those that were moderately active (mean 3.70, SD 0.71). Those that were sufficiently vigorously active had a lower mean BRS score of 3.53 (SD 0.74), and those that were vigorously active had a mean score of 3.75 (SD 0.68).

Table 2 Physical activity levels compared across each resilience level ($n = 4040$)

Physical activity levels	Resilience levels			
	Low	Normal	High	
Moderate PA (over last 7 days)				
None	2827 (70.0)	571 (79.0)	2037 (68.4)	219 (64.2)
1–2 days	526 (13.0)	63 (8.7)	423 (14.2)	40 (11.7)
3–4 days	282 (7.0)	39 (5.4)	217 (7.3)	26 (7.6)
5–6 days	144 (3.6)	19 (2.6)	103 (3.5)	22 (6.5)
Every day	261 (6.5)	31 (4.3)	196 (6.6)	34 (10.0)
Meeting sufficient moderate PA				
No	3635 (90.0)	673 (93.1)	2677 (90.0)	285 (83.6)
Yes	405 (10.0)	50 (6.9)	299 (10.0)	56 (16.4)
Vigorous PA (over last 7 days)				
None	3479 (86.1)	662 (91.6)	2541 (85.4)	376 (80.9)
1–2 days	283 (7.0)	34 (4.7)	220 (7.4)	39 (8.5)
3–4 days	135 (3.3)	14 (1.9)	105 (3.5)	16 (4.7)
5–6 days	56 (1.4)	60 (0.8)	55 (1.5)	6 (1.8)
Every day	87 (2.2)	7 (1.0)	66 (2.2)	14 (4.1)
Meeting sufficient vigorous PA				
No	3897 (96.5)	710 (98.2)	2866 (96.3)	321 (94.1)
Yes	143 (3.5)	13 (1.8)	110 (3.7)	20 (5.9)

There was a higher percentage of respondents in the high-resilience group that met the guidelines for weekly moderate physical activity (16.4%), in comparison to those reporting normal resilience (10.0%) or low resilience (6.9%), as shown in Fig. 1. Similarly, for meeting the weekly vigorous physical activity guidelines, those respondents who had higher resilience had a higher participation rate in physical activity (5.9%) than those in the normal (3.7%) or low-resilience groupings (1.8%), as shown in Fig. 2.

Data were not normally distributed and therefore a Mann–Whitney test was used to compare the difference between those sufficiently active and those not in terms of mean resilience scores. Those not sufficiently moderately active scored significantly lower in resilience mean

**Fig. 1** Summary of moderate physical activity results

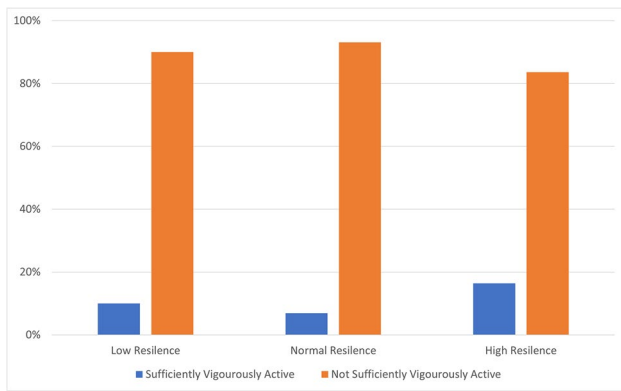


Fig. 2 Summary of vigorous physical activity results

scores than those who were sufficiently moderately active ($U = 633,287.00$, $p < 0.001$). Similarly, those not sufficiently vigorously active scored significantly lower in resilience mean scores than those who were sufficiently moderately active ($U = 224,885.50$, $p < 0.001$).

Chi-square tests were also used to examine differences in physical activity by resilience levels. The association between resilience and days of moderate physical activity was significant $\chi^2(8, n = 4040) = 49.89$, $p < 0.001$, Cramer's $V = 0.08$. This suggests that those who had higher resilience were more likely to have participated in moderate physical activity for a higher number of days than those who had lower resilience. Similarly, the association between resilience and days of vigorous physical activity was significant, $\chi^2(8, n = 4040) = 30.33$, $p < 0.001$, Cramer's $V = 0.06$. This suggests that those who had higher resilience were more likely to have participated in vigorous physical activity for a higher number of days than those who had lower resilience.

A subgroup analysis examining gender and age were conducted to examine differences in resilience and physical activity levels. In terms of age, the association between days sufficiently moderately active and normal resilience levels were significantly different between those 65 years < 85 years and those 85 years and older, $\chi^2(8, n = 4040) = 9.40$, $p < 0.001$, Cramer's $V = 0.06$. The association between days sufficiently vigorously physically active and normal resilience levels were significantly different between those 65 years < 85 years and those 85 years and older, $\chi^2(8, n = 4040) = 2.80$, $p = 0.009$, Cramer's $V = 0.05$. Those with lower resilience levels were less likely to take part in any moderate or vigorous physical activity levels ($p < 0.001$). The 65 < 85 year old group had better mean resilience scores (3.54) than the 85 + group (3.51). While the 65 < 85 year old group had a higher percentage meeting the moderate physical activity guidelines (10.5%) and vigorous physical activity

(3.8%) guidelines than the 85 + age group (4.4% and 0.6% respectively).

In terms of age, there was a significant difference in sufficient moderate physical activity weekly ($X^2(4, n = 4040) = 13.07$, $p < 0.001$, Cramer's $V = 0.057$) and sufficient vigorous activity ($X^2(4, n = 4040) = 9.51$, $p < 0.001$, Cramer's $V = 0.079$), with those in the 65 < 85 age group being more active than those in the 85 years and older age group. On further analysis, those in the subgroup of 65 to < 85 ($\chi^2(8, n = 4040) = 45.80$, $p < 0.001$, Cramer's $V = 0.08$) with lower resilience were significantly less likely to be take part in any days of moderate physical activity on a daily/weekly basis. Similarly, 65 to < 85 ($\chi^2(8, n = 4040) = 28.76$, $p < 0.001$, Cramer's $V = 0.06$) with lower resilience were significantly less likely to be take part in any days being vigorously physical active on a daily/weekly basis. In the 85 years and older group there was no significant difference in terms of resilience and days moderately active ($\chi^2(8, n = 4040) = 8.89$, $p = 0.352$, Cramer's $V = 0.11$) or vigorously physically active ($\chi^2(8, n = 4040) = 3.56$, $p = 0.736$, Cramer's $V = 0.07$).

In terms of gender, the association between days of sufficient vigorous physical activity and normal resilience levels was significantly different between male and female respondents, $\chi^2(1, n = 4040) = 35.19$, $p < 0.001$, Cramer's $V = 0.11$. The association between days of sufficiently moderate physical activity and normal resilience levels was significantly different between male and female respondents, $\chi^2(1, n = 4040) = 15.84$, $p < 0.001$, Cramer's $V = 0.07$, while the association between days of sufficient moderate physical activity and high resilience levels was significantly different between male and female respondents, $\chi^2(1, n = 4040) = 3.96$, $p < 0.05$, Cramer's $V = 0.11$.

Males had a higher mean resilience scores (3.62) than their female counterparts (3.45), while the male group had a higher percentage meeting the moderate physical activity guidelines (12.6%) and vigorous physical activity guidelines (5.6%) than the female group (7.8% and 1.7% respectively). On further analysis, those in the subgroup of male participants ($\chi^2(8, n = 4040) = 23.35$, $p = 0.003$, Cramer's $V = 0.08$) with lower resilience were significantly less likely to be take part in any days being moderate physical activity on a daily/weekly basis. Similarly, males ($\chi^2(8, n = 4040) = 20.38$, $p = 0.009$, Cramer's $V = 0.07$) with lower resilience were significantly less likely to have taken part in any days of vigorous physical activity on a daily/weekly basis. In the female group, there was no significant difference in terms of resilience and days moderately active ($\chi^2(8, n = 4040) = 21.36$, $p = 0.06$, Cramer's $V = 0.07$) or vigorously physically active ($\chi^2(8, n = 4040) = 12.25$, $p = 0.140$, Cramer's $V = 0.05$).

An ordinal regression revealed that an increase in moderate activity days was associated with higher levels of

resilience, with an odds ratio of 0.081 (95% CI, 0.026 to 0.248), Wald χ^2 (2) 19.252, $p < 0.001$. An increase in vigorous activity days was associated with higher levels of resilience, with an odds ratio of 0.027 (95% CI, 0.003 to 0.236), Wald χ^2 (2) 10.64, $p < 0.001$.

Discussion

The current study examined cross-sectional data from WAVE 1 of the NICOLA study with the primary aim of exploring the association between physical activity (moderate and vigorous levels) and resilience in older adults. The results indicated that higher levels of moderate or vigorous activity in older adults were associated with higher levels of resilience. Those who did not take part in any daily physical activity were more likely to report lower resilience, which may be problematic for their future health.

In terms of physical activity, this study has found that very few older adults met the recommended physical activity guidelines. For the overall sample, only 16.4% of respondents in the high resilience group met the guidelines for weekly moderate physical activity, while the figures for those reporting normal resilience (10.0%) or low resilience (6.9%) were even lower. Similarly, those respondents who had higher resilience had a higher participation rate in physical activity (5.9%) than those in the normal (3.7%) or low resilience groupings (1.8%). All these figures within this study are alarmingly low. Research has suggested that the levels of physical inactivity have steadily increased over the last decade as a result of urbanisation, built environments, and increasing sedentary behaviour, which has also led to increased mental health issues (Sheppard 2021). These factors could be the rationale behind the low rate of physical activity amongst the population examined within this study. In comparison with previous Northern Ireland data showing physical activity in 41% of older adults (Cunningham and O'Sullivan 2020), the figure in this study is worryingly low.

A study by Majnarić et al. (2021) indicated that lower resilience in older adults was associated with accelerated aging and more health complications. This suggests that health-preserving behaviours such as physical activity have an important role in addressing these effects, whilst also directly impacting disease risk. A study by Zach et al. (2021) also found that physical activity was associated to higher resilience but that older age groups had lower resilience than younger age groups, which may correspond with age-related declines in physical activity. Martinez-Moreno et al. (2020) explored the effects of physical activity on resilience in older adults. They found that only 43.6% of older adults in the study engaged in physical activity more than 3 days a week. Similarly to the present study, Martinez-Moreno et al. (2020) demonstrated older adults who regularly engaged in

physical activity reported higher scores in resilience. Finally, Kukihara et al. (2018) also that older adults in Japan who were physically active have higher resilience, and also greater morale, and lower risk of depression symptoms, in comparison to those who were insufficiently active.

Musich et al. (2022a, b) examined the association of physical activity with loneliness, social isolation, and selected psychological protective factors among older adults. The authors found that moderate physical activity was associated with 27% increased likelihood for high resilience. Overall, the results of this study highlight the importance of examining resilience and physical activity in older adults. Future research is warranted to determine if there is a dose–response relationship between resilience levels and physical activity in older adults. Interestingly, findings from the current study indicated that those who were moderately sufficiently active had a lower mean BRS score than those who were vigorously sufficiently active. Based on these findings, intervention programmes for older adults should be developed to increase physical activity levels and potentially improve resilience in older adults particularly within Northern Ireland, as the current levels are low.

Limitations and strengths

The main advantage of this study is its examination of resilience and physical activity in older adults, who are often under-studied. In this study we used cross-sectional data from WAVE 1 of the NICOLA study, this allows for the association between the outcomes to be fully examined. Additionally, the inclusion of range of backgrounds (education status, drinking status, smoking status) was a strength as it provided evidence from multiple circumstances. However, a limitation of the cross-sectional method used is that the causal nature or direction of the association cannot be established (Wang and Cheng 2020).

The data in the study was used conducting a secondary data analysis. While this analysis can be beneficial in examining data in larger samples and populations not normally easy to reach, it does have its challenges. The researchers in this study did not collect the data and therefore had no control of the type of variables collected or methods used. The current study used the IPAQ and BRS, which have both been shown to be reliable and to be valid instruments to examine physical activity and resilience. Another limitation is that CAPI, while an efficient way at achieving higher quality of data, can be difficult to conduct in some areas, which means possible participants may have been excluded. Additionally, CAPI does not collect any comments of qualitative information that may be useful in explaining the outcomes and results of the study. The findings of this study are not representative of the general

Northern Ireland population and the overall older adult population across the United Kingdom; however, it does provide insight into this topic and therefore may spark further insights for future investigations.

Conclusion

As the population ages, resilience and physical activity levels become important to help improve physical and mental health outcomes. The findings of this study indicated that higher resilience levels are associated with higher levels of moderate and vigorous physical activity levels. Worryingly, a large percentage of the older adult population are not sufficiently active, and this is something that needs to be addressed. The findings suggest that with these low levels of physical activity, interventions should be created to target this population.

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Author contributions All authors listed have contributed sufficiently to this study and have read and approved the final manuscript.

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Availability of data and materials The data from the Northern Ireland Cohort for Longitudinal Ageing (NICOLA) are available but restrictions apply to the dataset. Data access is available by request through the NICOLA Data Access Committee.

Declarations

Ethical considerations and consent to participate Consent for the study was obtained from all study participants before the commencement of the research, and ethical approval was obtained by the School of Medicine, Dentistry and Biomedical Sciences Ethics Committee, Queen's university Belfast (SREC 12/23).

Consent for publication All participants in the original study (NICOLA project) agreed to data being used for publications.

Conflict of interest The authors declare no competing interests. The authors alone are responsible for the interpretation of the data, and any views or opinions presented are solely those of the authors and do not necessarily represent those of the NICOLA Study team.

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