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Patterns in health-related behaviours and fall injuries among older people: a population-based study in Stockholm County, Sweden

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Abstract

Aim: we identified clusters of older people with similar health-related behaviours and assessed the association between those clusters and the risk of injurious fall.
Methods: we linked self-reported and register-based data on the over-65s from the Stockholm public health cohort ($N = 20,212$). Groups of people with similar health-related behaviours were identified by cluster analysis using four measures of physical activity, two of smoking and alcohol habits and two individual attributes (age and type of housing). The association between clusters and falls leading to hospitalisation (422 cases) was studied using a nested case–control design. Odds ratios (ORs), crude and adjusted for health status, were compiled by cluster using the one with the most 'protective' health behaviour profile as the reference.
Results: five clusters were identified revealing a variety of combinations of health-related behaviours, all linked to specific age groups and types of housing and with a tendency towards higher levels of physical activity among the younger ones. The risk of injurious falls differed across clusters, and for three out of four, it was significantly higher than in the comparison cluster. Adjusting for health status only partially reduced the ORs for those clusters and this was observed both in men and women.
Conclusion: health-related behaviours aggregate in different manners among older people. Some health-related profiles are associated with an excess risk of falls leading to hospitalisation. Although this is partly a reflection of age differences across clusters, health status alone cannot fully explain the association.

Keywords: *physical activity, smoking, alcohol use, health status, follow-up, older people*

Introduction

Falls are a major cause of morbidity and mortality among older people [1]. Healthy lifestyles can help to prevent either fall occurrence or serious consequences of fall [1–8]. This is true for good or maintained strength and physical balance [9–12] but also for physical activity [4, 9, 13, 14]. The association between alcohol consumption and fall is less straightforward, with excessive consumption increasing the risk [15–17], but moderate use not necessarily doing so [4, 18].

The effect of those health-related behaviours on fall injuries in older people has mainly been studied one at a time and little attention has been paid to how they cluster with one another and with age. At community level, older people are a heterogeneous group, and health and safety promotion tailored to some specific groups may be more effective than general and less targeted measures.

The aim of this study is to identify such specific groups of older people with similar health-related behaviours and assess how the association with the risk of injurious fall differs across those groups.

Methods

Data on the over-65s were extracted from the Stockholm Public Health Cohort, a population-based sample with self-reported questionnaire information linked to register data, informing about health status, health-related behaviour and living circumstances [19]. The data for the current study came from the 2010 survey ($N = 21,747$; response rate 73.5%; 2.5% living in institutions) [19]. We excluded those who had been hospitalised after a fall during the year prior to the survey to avoid reverse causation ($n = 279$). We also excluded those who did not respond to two or more of the questions on health-related behaviours to avoid formation of uninformative clusters ($n = 725$) and those with no strata or weights information (see below) ($n = 531$), with 20,212 remaining (92.5% of the respondents). Those 725 with missing data were more often older, female, unmarried and foreign-born ($P < 0.001$).

Table 1. Description of the five clusters resulting from the cluster analysis[a]

	Cluster 1, $n = 5,436$, 26.9%	Cluster 2, $n = 6,440$, 31.9%	Cluster 3, $n = 3,105$, 15.4%	Cluster 4, $n = 2,273$, 11.3%	Cluster 5, $n = 2,958$, 14.6%	Total, $n = 20,212$, 100%
Age (in years)						
65–69	**39.9**	**73.2**	0.5	0.0	20.1	37.1
70–74	**54.5**	23.8	0.0	0.0	18.9	25.0
75–79	0.60	0.3	**99.6**	0.0	8.6	16.8
80–84	0.8	0.4	0.0	**100.0**	3.2	12.1
85+	4.1	2.4	0.0	0.0	**49.2**	9.1
Housing form						
Own home	**55.8**	**42.6**	36.6	27.9	17.8	39.9
Tenant-owned accommodation	26.2	**36.8**	**38.0**	**41.3**	32.7	34.1
Rented accommodation	16.3	20.1	**24.9**	**29.7**	**30.5**	22.4
Other/Missing	1.7	0.5	0.6	1.1	**19.0**	3.6
Exercising						
Almost never	17.3	21.1	27.5	**34.8**	**60.2**	28.4
<1 h/week	11.9	**27.1**	19.2	20.0	16.7	19.5
1–3 h/week	**40.1**	**43.7**	37.7	32.7	17.7	36.7
>3 h/week	**28.9**	7.0	13.5	9.5	3.8	13.7
Missing	1.9	1.1	2.5	2.9	1.7	1.8
Walking/cycling						
<20 min/day	10.1	25.3	21.4	**32.9**	**61.7**	26.8
20–40 min/day	29.6	**51.4**	**45.5**	40.6	25.4	39.6
>40 min/day	**59.8**	23.0	32.3	25.7	12.4	33.1
Missing	0.5	0.3	0.7	0.8	0.6	0.5
Household chores						
<1 h/day	8.2	18.3	14.1	21.6	**54.8**	20.7
1–2 h/day	23.6	**58.5**	**42.2**	38.0	26.1	39.6
2–3 h/day	**30.9**	19.0	**24.6**	23.3	13.0	22.7
>3 h/day	**37.0**	3.8	**18.4**	16.0	5.0	16.5
Missing	0.4	0.3	0.7	1.2	1.1	0.6
Sedentary behaviour						
Most of the time	0.9	8.7	6.2	**14.1**	**46.7**	12.4
About half the time	20.1	**59.5**	**45.8**	**44.0**	37.2	41.8
Less than half the time	**76.8**	29.9	**44.9**	38.0	12.7	43.2
Missing	2.2	1.9	3.1	**3.9**	**3.4**	2.6
Alcohol use						
Never drink	8.1	4.2	8.9	**13.8**	**24.3**	10.0
Drink but not binge drink	**66.2**	37.7	**65.0**	**65.5**	54.8	55.2
Binge drink at least once a year	24.3	**56.9**	24.1	18.0	18.1	33.0
Missing	1.3	1.2	2.0	2.7	2.8	1.8
Smoking						
Never smoked	**57.4**	29.8	**50.6**	**56.1**	**55.7**	47.2
Previous/current smoker	41.4	**68.9**	48.1	41.7	42.7	51.4
Missing	1.2	1.4	1.3	2.2	1.6	1.4

[a]The categories marked in bold are those that contributed significantly ($P < 0.05$) to the formation of each class.

We conducted in sequence a cluster analysis and a nested case–control study. Clusters of individuals were determined using six variables describing the respondents' behaviours together with their age (five categories) and housing form (four categories). Nominal categories were created for each health-related behaviour (see first column, Table 1), describing how active the respondents were: weekly exercise (last 12 months) in terms of: daily walking/cycling; time spent daily on household chores (including housework and gardening); and time spent daily in sedentary activity, as well as smoking habits (dichotomised, with 47.2% never having smoked) and alcohol use. In the latter case, we differentiated those who did not drink in the last 12 months (10.0%) from those who drink and those who binge drink (one bottle of wine on one and the same occasion). The correlation between these health-related behaviours was not remarkably strong (Cramer's $V < 0.3$).

Clusters were identified by means of the Hierarchical Ascendant Classification (HAC) [20, 21]. It is a classification technique suitable for nominal data that divides the study group into a number of (un-empty) clusters so that every individual belongs to one and only one cluster [21, 22]. The system of classes formed is dichotomous and each of its bonds is the origin of two classes [21, 22]. The individuals are classified based on their resemblance, i.e. their proximity, estimated by the χ^2 metric. Four criteria are used to decide on what level of the hierarchy (how many clusters) the results should be presented. Low intra-cluster variance, or 'compactedness' of a cluster, indicates high similarity among the individuals. The inter-cluster variance, or 'separateness', indicates how distinct neighbouring clusters are from one another. The HAC aims to minimise the variance within clusters and maximise the variance between them. The third criterion is the 'consistency' in the interpretation of clusters, i.e. whether the categories that contributed most significantly to the formation of the cluster ($P < 0.05$) provide an informative interpretation. The last criterion is the 'informational benefit' of moving down or up in the hierarchy. In the Spad software (version 7.4), the classification follows a factor analysis that maximises both the homogeneity intra-cluster and the separateness inter-cluster. In this study, the HAC was performed on the first six factors of the FAC. The software used can handle small categories (see Table 1) by setting them as 'passive' in the analyses, which we did with the category 'missing' in all health-related behaviours and that for housing.

We assessed the association between cluster and the risk of injurious fall using a nested case–control design. Cases were prospectively identified through the National Patient Register and hospital discharge diagnoses (ICD-10 codes W00-W19) during a 16-month period (01.09.2010–31.12.2011) ($N = 422$). The index date for the cases was the admission date. Controls were those who were not hospitalised for a fall injury during the study period ($N = 19{,}790$), and their index date was set randomly during the study period.

Odds ratios (ORs) with 95% confidence intervals were compiled using logistic regression (SAS version 9.3), and the cluster of respondents showing the most favourable (protective) health-related behaviours was used as reference group. The ORs were adjusted for the stratified sampling methods and calibration weights that serve to adjust for non-response bias and are based on information extracted from various Swedish registers [19].

The model was further adjusted for individual health status. A range of measures was considered that included BMI (four categories derived from self-reports of height and weight: underweight (<18.5); normal (18.5–24.9), overweight (25–29) and obese (≥30)); medication use (number of dispensed medications during the 90 days prior to the index date; extracted from Swedish Prescribed Drug Register); ever having been diagnosed by a physician with depression, diabetes, chronic obstructive pulmonary disease, angina or congestive heart failure; suffering from reduced mobility; sleep problems; poor mental health (if scoring ≥3 on the General Health Questionnaire (GHQ-12)); and being treated for high blood pressure by either medication or lifestyle changes. Other factors like long-term limiting disease and persistent fatigue were too highly correlated with the other health status variables (Cramer's $V \geq 0.3$, see also [23]) and hence not included. We assessed the association between each health status variable and fall injury, adjusting for sex, and retained those that were significant ($P < 0.05$). These variables were then all entered into one model testing the association between cluster and fall injury: number of medications, BMI, reduced mobility and poor mental health were significant and used in the final analysis. The analyses were stratified by sex.

The study was approved by the Regional Ethical Review Board of Stockholm.

Results

The ages of the respondents ranged from 65 to 104 years (mean = 73.5; standard deviation = 6.9; median = 72), with 52.9% being women, a majority (63.1%) living in their own home or tenant-owned accommodation. Five clusters were identified, as shown in Table 1, and their categories that contributed significantly to their formation ($P < 0.05$) are marked in bold. The descriptions that follow are based on these categories and the labels of the clusters highlight the most significant ones for the formation of the cluster.

Cluster 1: Physically active and young old (26.9%)

In Cluster 1, a significantly high proportion of people report being sedentary less than half of the time and walking/cycling >40 min daily. They are also busy with household chores 2–3 or >3 h daily and exercise 1–3 or >3 h per week above the average. People aged 65–69 and 70–74 years are over-represented in the cluster as are, although slightly less, those owning their own house, non-smokers and those who drink but do not binge drink.

Cluster 2: Young old people with a tendency to binge drink and smoke (31.9%)

Those from the youngest age group (65–69 years) are over-represented and report higher proportions of binge drinking,

previous or current smoking, and residing in a house that they own or in tenant-owned accommodation. They tend to report lower levels of physical activity than Cluster 1 and relative to the whole population, a higher proportion report that they are sedentary about half of the time, work with household chores 1–2 h per week, and exercise alternatively <1 h per week or 1–3 h per week.

Cluster 3: Middle old with a tendency to drink and be slightly physically active (15.4%)

This cluster is highly representative of those aged 75–79 years. Typical for them is an over-representation of those who report drinking alcohol but not binge drinking, those walking/cycling 20–40 min daily and those who are sedentary about half of the time or less than half the time during their daily activities. Those who live in tenant-owned accommodation and those in rented accommodation are slightly over-represented, as well as those who report spending time on household chores 1–2, 2–3 or >3 h daily, and never having smoked.

Cluster 4: Very old people who do not binge drink or smoke (11.3%)

This cluster includes a marked over-representation of those aged 80–84 years and those who either never drink or drink but do not binge drink and are non-smokers. A higher proportion also lives in tenant-owned accommodation or rented accommodation. They are somewhat less physically active with a slightly higher proportion of them compared with the whole sample reporting being sedentary most of the time or about half of the time and walking/cycling 20–40 min a day and almost never exercising.

Cluster 5: Sedentary, less physically active, very old people (14.6%)

This last cluster is more typical of those less physically active, with being mostly sedentary as a strong characteristic of the cluster, together with doing household chores <1 h a day, walking/cycling <20 min a day and almost never exercising. People from the 85 and over age group are over-represented. A higher proportion of those people live in other forms of

Table 2. Characteristics of the study sample across health-related behaviour clusters

	Cluster 1: Physically active and young old *n* = 5,436	Cluster 2: Young old with a tendency to binge drink and smoke *n* = 6,440	Cluster 3: Middle old, with a tendency to drink and slightly active *n* = 3,105	Cluster 4: Very old who do not binge drink or smoke *n* = 2,273	Cluster 5: Sedentary, less physically active, very old *n* = 2,958	Total *n* = 20,212
Mean age (SD)	70.66 (4.52)	68.60 (4.02)	76.85 (1.55)	81.82 (1.38)	79.52 (9.18)	73.51 (6.94)
Sex						
Male	40.1	55.1	45.4	43.5	47.4	47.2
Female	59.9	44.9	54.6	56.5	52.6	52.9
Number of medications						
0 medication	44.5	44.7	33.3	32.4	37.7	40.5
1 medication	14.3	13.0	11.3	9.2	8.2	12.0
2 medications	11.9	11.2	12.3	11.0	8.8	11.2
3 medications	9.6	9.3	11.3	11.4	8.3	9.7
4 medications	7.0	7.2	9.8	9.6	9.1	8.1
≥5 medications	12.7	14.6	22.1	26.5	28.1	18.5
BMI						
Under weight	1.6	1.1	1.4	2.1	4.2	1.8
Normal weight	50.4	39.3	47.2	50.2	45.2	45.6
Over weight	39.5	43.1	39.3	37.2	34.1	39.6
Obese	8.6	16.5	12.1	10.5	16.6	13.0
Presence of:						
Sleep problems	36.3	37.4	40.4	41.6	45.7	39.2
Reduced mobility	13.3	19.9	28.7	43.6	58.2	27.6
Poor mental health (GHQ-12 ≥3)	7.1	9.0	11.2	14.0	21.8	11.2
Depression diagnosis	7.7	8.4	6.0	7.1	8.6	7.8
Diabetes diagnosis	8.5	11.6	13.4	12.1	15.6	11.7
Chronic obstructive pulmonary disease diagnosis	3.0	4.6	6.4	7.3	8.9	5.4
Angina diagnosis	6.5	8.1	11.5	14.4	15.2	9.9
Congestive heart failure diagnosis	3.6	5.4	8.9	13.8	15.5	7.8
High blood pressure	41.8	46.6	56.2	56.1	55.9	49.2
Fall injury	1.0	0.9	1.9	3.4	5.9	2.1

Table 3. The association between health-related behaviour clusters and risk of fall injury represented in odds ratios (ORs) with 95% confidence intervals (CI)

Model	Cluster 1: Physically active and young old	Cluster 2: Young old with a tendency to binge drink and smoke	Cluster 3: Middle old, with a tendency to drink and slightly active	Cluster 4: Very old who do not binge drink or smoke	Cluster 5: Sedentary, less physically active, very old
Crude	1.00	0.93 (0.61–1.43)	**1.97** (1.28–3.02)	**4.20** (2.81–6.26)	**6.61** (4.62–9.46)
Adjusted by health status[a]	REF	0.93 (0.59–1.45)	1.57 (0.98–2.51)	**2.72** (1.72–4.30)	**4.03** (2.64–6.13)
Stratified by sex[a]					
Males	1.00	1.12 (0.54–2.31)	1.68 (0.77–3.64)	**3.05** (1.40–6.67)	**3.80** (1.90–7.61)
Females	REF	0.83 (0.47–1.49)	1.57 (0.86–2.85)	**2.70** (1.53–4.76)	**4.47** (2.61–7.63)

[a]Adjusted for number of medications, BMI, reduced mobility and poor mental health. Values marked in bold are significant at the $p < 0.05$ level.

housing or in rented accommodation and report never drinking alcohol and being non-smokers.

Table 2 presents additional attributes of the clusters with individuals in Cluster 5 tending to have more health problems than others. Those from Clusters 1 and 2 are similar in many ways, although slightly higher proportions of health problems are reported in the latter; most strikingly, obesity and overweight. Cluster 2 has a lower proportion of females than males as opposed to all other clusters. Cluster 3 reports higher proportions of high blood pressure and the use of more medications compared with the total study group.

There is an association between clusters and risk of fall injury (Table 3). Overall, clusters with less favourable health-related behaviours have an excess risk of injurious falls. Adjusting for health status reduces the strength of the association, which remains significant. The risk of falls is not significantly different in Clusters 2 and 3 than for Cluster 1. However, Cluster 4 has an OR of nearly 2.7 (95% CI: 1.7–4.3) and the OR for Cluster 5 is fourfold higher (95% CI: 2.6–6.1). The stratified analyses show similar estimates for men and women.

Discussion

The association between age and health-related behaviours among older people is established [24, 25] as is that between individual healthy behaviours and the risk of falling or that of being injured when falling [1–8]. When it comes to how health-related behaviours relate to one another, this study highlights five clusters of community dwellers with particular profiles composed of combinations of health-related behaviours and housing form in turn linked to particular age groups. Two clusters (3 and 4), smaller, are mainly composed of people aged 75–79 or 80–84 years and two others (Clusters 1 and 2), larger, better characterise the 65–69 and/or 70–74 years old.

We also observed an association between cluster and the risk of injurious fall, with an excess risk among people from Clusters 3 to 5 compared with their peers from Cluster 1. While the excess risk for Cluster 3 could partly be explained by differences in health status, this did not apply for Clusters 4 and 5. This difference may be a reflection of higher proportions of people with sedentary behaviours and low levels of physical activity in those clusters [4, 9, 13, 14].

It is not possible based on the study design to draw conclusions as to whether there are specific factors that can be singled out and explain the observed associations or, in more general terms, what mechanism lies behind them. That people from Cluster 2 are more similar in their risk level than those from Cluster 1 may have different explanations. They may be similar in many aspects, even some which are not captured by the study, and their health-related behaviours are not different enough for their risk of falls to be different. Alternatively, they are different in ways that we did not capture but that do not influence the association measured, even after adjustment for health status—or when stratifying by sex. The gender similarity in the cluster-specific odds of injurious fall is noteworthy in spite of the higher estimates in men in all but one cluster.

Besides having a strong design and a large sample, our study is one of the few population-based ones in this research area. Recall bias regarding injurious falls was minimised by using register data. Reverse causation bias was avoided by excluding respondents hospitalised for a fall injury during the year prior to the survey. The assessment of health-related behaviours and health status prior to outcome is a strength but some of the measures may have changed in different directions during the follow-up. The use of self-reported data also gave access to information that is seldom available in health records—not only health-related behaviours but also a diversity of health attributes that contributed to minimizing the risk for residual confounding. However, we missed factors that are seldom diagnosed like osteoporosis that could be related to several health-related behaviours.

This study represents the situation of the vast majority of older people in Stockholm County—and the country as a whole, as it is most common for older Swedish people to live at home [26]. It may however reflect the situation of healthier people, and in spite of the high response rate and the use of calibration weights to correct for non-response biases, the relative size of the clusters among community dwellers is uncertain. Further, the associations observed apply to fall injuries leading to hospitalisation, an outcome for which coverage is high in Swedish registers [27], but whether this applies also to less severe falls is uncertain.

Our results reinforce the notion that, within a community, older people cannot be regarded as a homogeneous 'target' group and that the development of 'single behaviour approaches' for health and safety promotion may not be straightforward. The fact that health-related behaviours tend to cluster, sometimes in an age-specific manner but not in all instances, is both encouraging and challenging when it comes to fall-prevention approaches.

Key points

- The health-related behaviours of older people cluster in various manners and five such clusters are representative of the population of older people in Stockholm County.
- There is an association between the cluster to which a person belongs and the risk of fall injury.
- Compared with the cluster of those reporting the most protective health behaviours, there is a tendency for the risk of fall injury to be much higher in the clusters with an accumulation of less favourable health behaviours, which are also the clusters in which people tend to be older.
- This association between cluster and the risk of injurious fall is found among both men and women, and it is only partly explained by health status in both instances.

Conflicts of interest

None declared.

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Inflammatory markers and physical performance in middle-aged and older people in Indonesia

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Abstract

Background: although recent studies have suggested that inflammation may play an important role in the process of ageing and in the development of disabilities, knowledge about the role of inflammation in physical performance decline among middle-aged and older people in the context of developing countries is limited.
Objectives: to examine the association between C-reactive protein (CRP) and the activities of daily living (ADL) among middle-aged (40–54 years old) and older (55–96 years old) people in Indonesia.
Data: data from a population-based sample, the Indonesia Family Life Survey (IFLS) 2007, were analysed. The data consist of 1,702 respondents of middle age (40–54 years old) and 2,017 older respondents who had completed information on ADL and CRP.
Methods: CRP concentrations in Dried Blood Spot (DBS) specimens were measured, using the validated enzyme-linked immunosorbent assay (ELISA) method. Thirteen items of ADL were used to measure physical performance. A three-level linear model was applied to take advantage of the nested structure of data at the individual level within the household and community levels.
Results: high levels of CRP were significantly associated with lower ADL for middle-aged and older people ($P < 0.001$). The model was adjusted for co-morbid conditions, health risk factors, medications, depressive symptoms and sociodemographic characteristics.
Conclusion: the significant association between the high level of CRP and lower ADL among older people in Indonesia is in line with earlier studies in the context of developed countries. This study provides an extension in which the significant association was also found in middle-aged people (40–54 years old).

Keywords: *inflammatory markers, physical performance, middle age, older people, Indonesia*

Introduction

Ageing is associated with a decline in physical performance that negatively affects quality of life and may compromise independence [1, 2]. The assessment of physical performance is a critical component of older people's health. For example, the summary of physical performance scores has been shown to be useful in the prediction of institutionalisation, disability and mortality [3]. A biological mechanism recently proposed to underlie the decline in physical performance is chronic inflammation [4]. Inflammation is the body's integrated reaction and defence against disturbances of homeostasis, particularly