RESEARCH REPORT

Physical activity among elderly people in a city population: the influence of neighbourhood level violence and self perceived safety

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Study objective: To study the associations between neighbourhood level violence/fear of violence and physical activity among elderly people, accounting for somatic health.
Design: Self reported data from the Oslo health study, a cross sectional study conducted in 2000, were linked with sociodemographic and social security data from Statistics Norway. A multilevel regression analysis was conducted by MlwiN using contextual level variables provided by the Oslo City Council.
Setting: Oslo, Norway.
Participants: 3499 inhabitants aged 74/5 (53.2% of all invitees).
Main results: 20.5% of the elderly were physically active less than one hour a week. Somatic health was clearly associated with physical activity among both men and women. Neighbourhood level violence was associated with physical activity only for men, while fear of violence was only associated with physical activity for women. Differences in somatic health did not explain differences in physical activity between neighbourhoods. These differences were explained by socioeconomic variables, and neighbourhood level violence/fear of violence.
Conclusions: In a sample of presumably healthy 75/76 year olds in Oslo, the associations between neighbourhood level violence and physical activity (among men), and fear of violence and physical activity (among women), are of the same sizes as those between somatic health and physical activity. These two dimensions of violence have, in contrast with somatic health, an explanatory function in exploring differences in physical activity between neighbourhoods in Oslo.

Recent studies suggest that low intensity physical activity among elderly people is associated with a reduced risk of dementia and consequently improved late life cognitive function.[1–5] McMurdo's[6] reassessment of original evidence together with a growing body of new research on physical activity among the elderly has shown that most health benefits can be gained by performing regular moderate intensity physical activities outside of formal exercise programmes. It has even been claimed that regular physical activity in old age can ''rejuvenate'' physical capacity by 10–15 years.[6] Thus, explaining variations in, and identifying obstacles towards, physical activity among the elderly should be of critical public health importance.

It is well reported that various health outcomes and health related behaviours are strongly related to social inequalities in education, income, and occupation, also in studies focusing on old age groups.[7–11] These findings related to individual characteristics have been found in most welfare states.[12] In the past few years however, a growing body of research has examined how characteristics of the environment are related to a variety of health outcomes.[13–18]

In a recent study, van Lenthe and colleagues[19] chose to exclude participants aged older than 70 years, assuming that their physical activity patterns are to a large extent dependent on their health status. We would like to challenge this assumption, bearing in mind that reduced mobility of some elderly may make them ''prisoners of space'',[20] meaning that their exposure to neighbourhood conditions and the degree to which those conditions are relevant to their health may be greater than they are for other age groups.[20–22]

There is a decreased likelihood of physical activity for those living in the socioeconomically most disadvantaged compared with the most advantaged neighbourhoods.[19] Furthermore, several studies have reported the relation between socioeconomic characteristics of the area and crime/fear of crime, claiming that crime is a mirror of the quality of the social environment,[23–25] and that crime and fear of crime in the neighbourhood may lead to reduced physical activity, and thereby social exclusion.[24–29] In this study we wanted to explore the association between physical activity among the elderly, and violence and fear of violence, adjusting for socioeconomic characteristics of the area and the people residing to it. Our hypothesis is that high density of violence in the neighbourhood and low self perceived safety among inhabitants in the neighbourhood will be associated with lower levels of physical activity among 75/76 year olds after taking individual health status into account.

METHODS

Data were obtained from the Oslo health study, a joint collaboration between the Oslo City Council, the University of Oslo, and the Norwegian Institute of Public Health in 2000–2001. A total of 40 888 persons were invited to participate. Participation rate was only 46%, but social inequality in health by different sociodemographic variables seemed unbiased.[30] Sociodemographic data from Statistics Norway were linked for all participants, providing official registers of income and fortune. Contextual level variables were provided by the Oslo City Council.

A total of 6737 citizens 75/76 years old were invited, of whom 3584 (53.2%) participated (58.2% among men, and 50.0% among women). They were all invited to attend a clinical examination at a health station, and only 35 reported residing in an institution. In our study we have analysed those 3499 participants who were included in the datafiles made by The Norwegian Institute of Public Health who conducted the practical part of the data collection.

Table 1 Distributions (percentages) of individual level variables from the Oslo health study. Percentages of shares with high level of physical activity (PA) in parentheses

	Men (n = 1503)		Women (n = 1996)		Total (n = 3499)	
	%	(% PA)	%	(% PA)	%	(% PA)
Cases of medical conditions*						
Angina pectoris (No)	84.4	(82.3)	88.2	(77.7)	86.8	(79.6)
Angina pectoris (Yes)	15.6	(76.6)	11.8	(66.1)	13.2	(72.2)
Asthma (No)	90.5	(82.1)	88.8	(77.4)	89.5	(79.5)
Asthma (Yes)	9.5	(77.4)	11.2	(66.6)	10.5	(70.9)
Chronic bronchitis (No)	92.5	(82.8)	94.0	(77.0)	93.2	(79.5)
Chronic bronchitis (Yes)	7.5	(68.5)	6.0	(67.8)	6.8	(68.2)
Diabetes (No)	91.2	(82.3)	94.4	(77.0)	93.0	(79.2)
Diabetes (Yes)	8.8	(74.5)	5.6	(63.7)	7.0	(69.6)
Osteoporosis (No)	98.1	(82.0)	76.3	(77.5)	85.8	(79.7)
Osteoporosis (Yes)	1.9	(66.6)	23.7	(70.9)	14.2	(70.7)
Fibromyalgia/chronic pain (No)	96.5	(82.3)	89.5	(77.7)	92.5	(79.8)
Fibromyalgia/chronic pain (Yes)	3.5	(63.8)	10.5	(65.9)	7.5	(65.6)
Myocardial infarction (No)	85.3	(82.5)	93.6	(77.6)	90.1	(79.6)
Myocardial infarction (Yes)	14.7	(76.6)	6.4	(56.1)	9.9	(69.2)
Stroke (No)	89.9	(82.7)	92.5	(77.5)	91.4	(79.7)
Stroke (Yes)	10.1	(71.9)	7.5	(61.1)	8.6	(66.6)
Medical conditions index						
(0) 0 conditions	53.6	(85.6)	48.6	(82.0)	50.8	(83.6)
(1) 1 or more conditions	42.9	(76.7)	46.7	(70.9)	45.0	(73.2)
Missing	3.5		4.7		4.2	
Self perceived safety in neigbourhood						
(0) Safe	77.3	(83.4)	32.1	(82.2)	51.5	(82.9)
(1) Slightly/very unsafe	19.6	(73.4)	64.2	(73.2)	45.1	(73.2)
Missing	3.1		3.7		3.4	
Marital status						
(0) Married	70.5	(83.3)	42.0	(76.2)	54.2	(80.1)
(1) Other marital status	24.0	(74.1)	58.0	(75.6)	43.5	(75.2)
Missing	5.5		0.0		2.3	
Income						
(0) Less than €25000	36.6	(77.7)	52.6	(69.6)	45.6	(72.3)
(1) More than €25000	36.5	(85.2)	11.3	(82.0)	22.2	(84.2)
Missing	26.9		36.1		32.2	
Education						
(0) Lower education	50.4	(81.0)	63.2	(74.5)	57.6	(76.9)
(1) College/university education	27.5	(84.2)	14.8	(88.5)	20.3	(85.9)
Missing	22.1		22.0		22.1	
Fortune						
(0) Lowest 5 deciles	34.3	(73.9)	55.6	(72.3)	46.5	(72.8)
(1) Highest 5 deciles	55.3	(86.7)	39.7	(82.6)	46.5	(84.6)
Missing	10.4		4.7		7.0	
Neighbourhood residency						
(0) Less than 5 years	5.9	(79.3)	4.0	(57.6)	4.8	(69.0)
(1) More than 5 years	89.7	(82.0)	91.5	(73.1)	90.7	(76.8)
Missing	4.4		4.5		4.5	

*Only valid percentages are shown (summed up to 100) for medical conditions. Missing (%) for men (range): 2.4–5.2. Missing (%) for women (range): 2.6–5.4.

Ethics and approvals

All the participants of the Oslo health study gave their written consent. The participants' names and personal ID numbers were omitted when data were used. The Norwegian Data Inspectorate approved the Oslo health study, the Regional Committee for Medical Research Ethics evaluated it, and it was conducted in full accordance with the World Medical Association Declaration of Helsinki.

Table 2 Level 2 variance (L2V) (random effects with standard errors (SE)) and odds ratio (95% confidence intervals) for (unadjusted) bivariate associations between high values (1) of independent variables and high level of physical activity

	Men				Women				Total			
Variables	L2V	SE	OR	95% CI	L2V	SE	OR	95% CI	L2V	SE	OR	95% CI
Empty model	0.138	(0.073)			0.105	(0.051)			0.106	(0.043)		
Medical conditions (≥1)	0.166	(0.083)	0.56	0.43, 0.75	0.099	(0.051)	0.54	0.43, 0.67	0.111	(0.046)	0.54	0.45, 0.64
Neighbourhood violence (high)	0.072	(0.054)	0.55	0.39, 0.78	0.104	(0.051)	0.87	0.62, 1.22	0.090	(0.039)	0.72	0.53, 0.96
Self perceived safety (low)	0.110	(0.066)	0.59	0.43, 0.82	0.076	(0.044)	0.61	0.48, 0.78	0.079	(0.036)	0.59	0.50, 0.71
Marital status (non-married)	0.130	(0.072)	0.63	0.46, 0.85	0.105	(0.051)	0.97	0.78, 1.21	0.108	(0.044)	0.78	0.65, 0.92
Income (high)	0.059	(0.055)	2.44	1.62, 3.66	0.086	(0.047)	2.57	1.49, 4.41	0.058	(0.031)	2.52	1.84, 3.45
Education (high)	0.115	(0.079)	1.64	1.14, 2.37	0.034	(0.037)	2.49	1.79, 3.65	0.052	(0.032)	2.05	1.59, 2.65
Fortune (high)	0.063	(0.056)	2.20	1.64, 2.95	0.075	(0.044)	1.73	1.36, 2.19	0.062	(0.062)	1.93	1.61, 2.31
Average income (high)	0.082	(0.057)	1.68	1.17, 2.41	0.000	(0.000)	1.99	1.60, 2.48	0.017	(0.018)	1.86	1.52, 2.28
Residency (>5 years)	0.127	(0.071)	1.07	0.61, 1.87	0.089	(0.048)	1.82	1.10, 3.01	0.099	(0.042)	1.38	0.96, 1.99

Individual variables

Physical activity was assessed by the question:''What kind of physical activity have you undertaken in the course of the past year? Estimate a weekly average for the year (light exercise, you do not sweat or feel out of breath)''. Answers were dichotomised into physical activity less than one hour a week (value 0) and more than one hour a week (value 1) (table 1).

Medical conditions were the number of diseases reported from a list of a total eight (table 1). They were dichotomised into no conditions (0) and one or more conditions (1). Respondents providing information on less than seven conditions were regarded as missing. *Self perceived safety* in the neighbourhood was derived from a question widely used: ''Would you feel safe walking alone in your neighbourhood in the evening?''.[26 29 31 32] The answers were dichotomised into feeling safe (0) and feeling slightly/or very unsafe (1). *Marital status* was dichotomised into married (0) and unmarried/ widow/widower/ divorced/separated/or other marital status (1). *Income* was total taxable income of 1999—that is, summing up occupational income, capital income, and transfers, and dichotomised between the lowest five deciles (0) and the highest five deciles (1). *Fortune* was defined as taxable wealth 1999, and dichotomised by a cut off at €37 000, which represents the interface between the lowest five deciles of fortune (0) and the highest five deciles of fortune (1). Data on income and fortune (measured for individuals, not households) were register linked files from Statistics Norway. *Education* was dichotomised into lower educational forms (0) and college or university education (1). Our final explanatory variable *neighbourhood residency* was dichotomised into less than five years of residency (0) and more than five years of residency (1).

Contextual variables

Neighbourhood violence gives the registered cases of violence per 1000 inhabitants in Oslo's 25 administrative boroughs (neighbourhoods). The level of violence was dichotomised by the median value. *Average income in neighbourhood* (for all inhabitants over 16 years) was dichotomised by the median value (€28 000). For both variables, the lower half was given the value 0, and the higher half the value 1.

Statistics

A multilevel regression analysis was conducted by MlwiN (version 1.10.007)[33 34] with 3499 persons (level 1) nested within 25 neighbourhoods (level 2). The dependent variable was a dichotomous outcome (low compared with high physical activity), and the model was binomial (logistic regression). Parameters were estimated using the penalised quasilikelihood (PQL) estimation method. Multilevel analysis typically contains two parts, the random and the fixed part. Variations between neighbourhoods in the outcome of interest (the random part) can be explained by the fixed effects of compositional and contextual factors. The percentage of the total variance in physical activity that was related to the neighbourhood (that is, intraclass correlation (ICC)) was approximated as: neighbourhood variance/(neighbourhood variance+$\pi^2/3$).[35] Furthermore, to investigate possible mediations on our fixed effects, interaction terms were tested. Neighbourhood violence and self perceived safety were analysed through marital status, percentage of men in the neighbourhood, and age distribution in the neighbourhood.

Men and women were analysed separately, as we wanted to explore sex specific associations more thoroughly. We also fitted separate models for self perceived safety and neighbourhood violence, to make their associations with physical activity more clear and interpretable. Thus, there is one analysis investigating neighbourhood violence and one investigating self perceived safety for both sexes.

RESULTS

A total of 20.5% of the elderly were physically active less than one hour a week (17.6% men and 22.6% women). Missing values on physical activity were 5.5% for men and 6.3% for women. In our study we used two explanatory variables from the contextual level. There were strong differences in violence between the neighbourhoods, with 20 times as many conducts per inhabitant in the neighbourhood with the most violence, compared with the neighbourhood with the least (minimum: 1.5 conducts per 1000 inhabitants, maximum: 31.4; mean 7.0). There were also strong differences in average income between the neighbourhoods, with almost three times as high average income in the most wealthy

Table 3 Level 2 variance (random effects, β, and SE), intraclass correlation (ICC), and odds ratio (95% CI) for associations between high values (1) of independent variables and high level of physical activity. Analysis for men (n = 1409)

	Model 1	Model 2	Model 3	Model 4
Violence analysis				
Variance	0.138 (0.073)	0.166 (0.083)	0.071 (0.056)	0.044 (0.064)
ICC	4.0	4.8	2.1	1.3
Constant (β0)	4.25 (3.48, 5.19)	5.74 (4.43, 7.43)	8.36 (6.14, 11.37)	6.61 (2.63, 16.5)
Medical conditions (one or more)		0.56 (0.43, 0.75)	0.55 (0.42, 0.73)	0.58 (0.41, 0.82)
Neighbourhood violence (high)			0.50 (0.35, 0.72)	0.54 (0.36, 0.81)
Marital status (non-married)				0.56 (0.38, 0.81)
Income (high)				1.32 (0.81, 2.15)
Education (high)				1.42 (0.93, 2.17)
Fortune (high)				1.98 (1.38, 2.84)
Average income (high)				1.02 (0.67, 1.56)
Residency (more than five years)				0.92 (0.40, 2.10)
Safety analysis				
Variance	0.138 (0.073)	0.166 (0.083)	0.136 (0.075)	0.141 (0.094)
ICC	4.0	4.8	3.9	4.1
Constant (β0)	4.25 (3.48, 5.19)	5.74 (4.43, 7.43)	6.47 (4.96, 8.45)	5.54 (2.16, 14.18)
Medical conditions (one or more)		0.56 (0.43, 0.75)	0.57 (0.43, 0.76)	0.59 (0.41, 0.84)
Self perceived safety (low)			0.61 (0.44, 0.85)	0.68 (0.45, 1.02)
Marital status (non-married)				0.56 (0.38, 0.82)
Income (high)				1.26 (0.77, 2.07)
Education (high)				1.33 (0.87, 2.03)
Fortune (high)				2.03 (1.41, 2.93)
Average income (high)				1.17 (0.72, 1.91)
Residency (more than five years)				0.83 (0.34, 2.01)

Table 4 Level 2 variance (random effects, β, and SE), intraclass correlation (ICC), and odds ratio (95% CI) for associations between high values (1) of independent variables and high level of physical activity. Analysis for women (n = 1864)

	Model 1	Model 2	Model 3	Model 4
Violence analysis				
Variance	0.105 (0.051)	0.099 (0.051)	0.100 (0.052)	0.000 (0.000)
ICC	3.0	2.9	2.9	0.0
Constant (β0)	3.08 (2.60, 3.64)	4.46 (3.61, 5.52)	4.65 (3.52, 6.13)	3.19 (2.30, 4.42)
Medical conditions (one or more)		0.54 (0.43, 0.67)	0.54 (0.43, 0.68)	0.56 (0.43, 0.73)
Neighbourhood violence (high)			0.92 (0.65, 1.29)	1.08 (0.82, 1.42)
Marital status (non-married)				0.78 (0.59, 1.03)
Income (high)				1.61 (0.84, 3.10)
Education (high)				1.85 (1.21, 2.83)
Fortune (high)				1.55 (1.16, 2.08)
Average income (high)				1.58 (1.19, 2.10)
Residency (more than five years)				1.29 (0.62, 2.67)
Safety analysis				
Variance	0.105 (0.051)	0.099 (0.051)	0.074 (0.045)	0.000 (0.000)
ICC	3.0	2.9	2.2	0.0
Constant (β0)	3.08 (2.60, 3.64)	4.46 (3.61, 5.52)	6.00 (4.58, 7.85)	3.49 (1.72, 7.06)
Medical conditions (one or more)		0.54 (0.43, 0.67)	0.55 (0.43, 0.69)	0.58 (0.44, 0.76)
Self perceived safety (low)			0.66 (0.51, 0.86)	0.64 (0.47, 0.87)
Marital status (non-married)				0.78 (0.59, 0.96)
Income (high)				1.60 (0.83, 3.09)
Education (high)				1.79 (1.16, 2.75)
Fortune (high)				1.53 (1.14, 2.06)
Average income (high)				1.54 (1.17, 2.04)
Residency (more than five years)				1.33 (0.70, 2.50)

neighbourhood, compared with the least (minimum: €22 700, maximum: €67 400, mean: €32 300).

Table 1 shows the distributions of individual level independent variables. For all variables, both individual and contextual (the latter not shown in table), there were larger percentages of elderly being physically active more than one hour a week among those who reported the assumed favourable values (for example, no medical conditions, feeling safe, high income, living in neighbourhood with high average income), than among those who reported less favourable values. Medical conditions' and self perceived safety's bivariate associations to physical activity was fairly similar for both sexes, while neighbourhood violence's association was only significant for men (table 2).

Medical conditions remained significant throughout the models in tables 3–5, meaning there was no evidence of confounding between medical conditions and our independent variables, and that one or more medical conditions were clearly associated with low level of physical activity. However, medical conditions did not lead to any substantial reduction of level 2 variance for either sex.

Table 5 shows that neither violence nor safety led to any substantial reduction in level 2 variance, in contrast with the socioeconomic variables in model 4. Adding these eliminated the significant association between neighbourhood violence and physical activity, whereas the association between self perceived safety and physical activity remained significant. These results, however, were very different when we explored

Table 5 Level 2 variance (random effects, β, and SE), intraclass correlation (ICC), and odds ratio (95% CI) for associations between high values (1) of independent variables and high level of physical activity. Analysis for all participants (n = 3499)

	Model 1	Model 2	Model 3	Model 4
Violence analysis				
Variance	0.106 (0.043)	0.111 (0.046)	0.093 (0.052)	0.005 (0.020)
ICC	3.1	3.2	2.7	0.1
Constant (β0)	3.50 (3.01, 4.08)	4.99 (4.15, 6.00)	5.95 (4.68, 7.56)	3.73 (2.22, 6.24)
Medical conditions (one or more)		0.54 (0.45, 0.64)	0.54 (0.46, 0.65)	0.57 (0.46, 0.70)
Neighbourhood violence (high)			0.71 (0.52, 0.96)	0.84 (0.67, 1.05)
Marital status (non-married)				0.69 (0.56, 0.85)
Income (high)				1.39 (0.95, 2.02)
Education (high)				1.58 (1.18, 2.11)
Fortune (high)				1.77 (1.41, 2.21)
Average income (high)				1.35 (1.07, 1.70)
Residency (more than five years)				1.11 (0.69, 1.77)
Safety analysis				
Variance	0.106 (0.043)	0.111 (0.046)	0.089 (0.040)	0.009 (0.022)
ICC	3.1	3.2	2.6	0.2
Constant (β0)	3.50 (3.01, 4.08)	4.99 (4.15, 6.00)	6.30 (5.17, 7.69)	4.02 (2.41, 6.70)
Medical conditions (one or more)		0.54 (0.45, 0.64)	0.56 (0.46, 0.66)	0.58 (0.47, 0.72)
Self perceived safety (low)			0.63 (0.53, 0.75)	0.69 (0.55, 0.86)
Marital status (non-married)				0.72 (0.58, 0.89)
Income (high)				1.32 (0.90, 1.93)
Education (high)				1.47 (1.09, 1.97)
Fortune (high)				1.74 (1.39, 2.18)
Average income (high)				1.42 (1.12, 1.80)
Residency (more than five years)				1.11 (0.69, 1.79)

them more thoroughly by analysing men and women separately in tables 3 and 4. Neighbourhood violence was then only significantly associated with physical activity for men, whereas self perceived safety was only significantly associated for women.

In model 4 we tested for interaction terms to investigate possible mediating factors through which the associations of neighbourhood violence and self perceived safety could be modified. None of these terms (described earlier) were significant and they did not lead to any important changes in the previous estimates (not shown in table).

The sex specific differences in associations were evident in the changes in level 2 variance and ICC throughout our models. The ICC expresses the strength of the positive correlation between the responses of persons within the same neighbourhood.[36] For men, neighbourhood violence seems to be the variable that led to the strongest reduction in level 2 variance (0.166 to 0.071), thus the ICC was reduced by 43% (4.8 to 2.1). For women, there were no such changes when neighbourhood violence was introduced, but there was a moderate reduction in level 2 variance when we entered self perceived safety (level 2 variance decreased from 0.099 to 0.074, ICC from 2.9 to 2.2). When entering (for both sexes) neighbourhood violence in the safety analyses and self perceived safety in the violence analyses, the newly entered variables were not significant and the already included estimates were unchanged, implying there was little overlap between neighbourhood violence and self perceived safety. The bivariate correlation between neighbourhood violence and self perceived safety was weak for both sexes, but stronger for men ($r = 0.170$, $p<0.01$) than for women ($r = 0.069$, $p<0.01$).

DISCUSSION

This study has shown that although somatic health status is associated with physical activity among 75/76 year olds in Oslo, differences between neighbourhoods in physical activity cannot be explained by differences in somatic health. From our analysis, differences between neighbourhoods in physical activity among men seem to be explained to a large extent by neighbourhood level violence. This is independent of socioeconomic background variables. For women there was some explanatory strength from self perceived safety, but differences seemed best explained by other socioeconomic background variables.

We have seen that the two dimensions of violence: the real and the perceived level, and their impact on physical activity, is of different importance to men and women. This is in accordance to previous studies suggesting that self reported fear of violence or subjective sense of insecurity in public places seems to represent an independent psychological consequence of crime at the population level apart from the direct physical and psychological consequences for the individual victims of crime.[26] According to Lindström and colleagues[26] previous studies have reported substantial and empirically observable age and sex differences in fear of violence. Elderly people and women are more likely to express self reported fear of violence or sense of insecurity in public places despite the fact that they are not necessarily victimised to any higher extent than others. This difference between men and women has been confirmed in our study. Thus, neighbourhood violence and self perceived safety are not confounding variables, but independent effects operating at different levels, and being of different importance to men and women.

We were surprised that the stepwise analyses gave no important changes in associations for medical conditions, neighbourhood violence (for men), and self perceived safety (for women) as additional variables were included in the models. Also, the introduction of neighbourhood violence and self perceived safety did not impose changes on the associations between medical conditions and physical activity. This implies that the main variables of this study (medical conditions, neighbourhood violence, and self perceived safety) are independently associated with physical activity, also after adjustment for socioeconomic variables.

Accordingly, when the neighbourhood variation is small, focusing intervention on neighbourhoods may be a rather inefficient strategy.[37] In our analyses we have seen that ICCs were higher for men (for women the ICCs were zero in the fully adjusted models), but more importantly, our analyses have shown that neighbourhood violence was a decisive factor in the reduction of ICC for men—that is, this reduction for men was explained by a contextual variable, which applies to all men in the neighbourhood. For women, self perceived safety was significantly associated with physical activity, but this is a compositional factor, and did not lead to any substantial decrease in level 2 variance or ICC, showing that low self percieved safety among women is not clustered at neighbourhood level. ICC for men was 4.1 in the fully adjusted model in the safety analysis, whereas it was 1.3 in the fully adjusted model in the violence analysis. This clearly shows that neighbourhood violence is an important factor in explaining between-district variations in men's physical activity, and that promoting physical activity among men is best done by efforts aimed at the neighbourhoods where violence rates are high. For women, the ICC was zero in both of the fully adjusted models, and neighbourhood violence was neither significant nor could reduce any level 2 variation. So it seems that such efforts will not have the same effect on women, whose self perceived safety does not correspond that much to the real level of violence, but must be regarded as a more psychologically complex anxiety that works independently of violence or place of residency.

Study limitations

Almost half of all invitees of the elderly (48.0%) did not participate in the study, which means our results may be hampered by selection bias. However, it is important to note

Policy implications

Efforts aimed at reducing violence in neighbourhoods where violence rates are high will most probably lead to increased physical activity among old men, whereas this cannot be expected to have the same effect for women.

What this paper adds

- Physical activity among elderly people is commonly considered a function of health status, but few studies have compared this with neighbourhood characteristics.
- Among non-institutionalised, comparatively healthy 75/76 year olds, violence in the neighbourhood (for men) and self perceived safety (for women) are as strongly associated to physical activity as somatic health. Differences between neighbourhoods in level of physical activity among the elderly are not explained by differences in health, but by socioeconomic characteristics, violence (for men) and partly by self perceived safety (for women).

that recruitment of elderly for a population based study is a much more difficult task than recruiting in other age groups. Arguably, many institutionalised and severely ill elderly did not participate. Although we are unable to record this, it is reasonable to assume that our study in fact is a study of comparative healthy and non-dependent 75/76 year olds. We do not find this detrimental to our study. If anything, it may have led to an underestimation of the socioeconomic differences in health.[8] But more importantly, the institutionalised and severely ill elderly are not of importance for our purposes, given the public health perspective from which this study was generated. In light of research showing that low intensity physical activity among the elderly may lead to rejuvenation of health, and is associated with a reduced risk of dementia and consequently improved late life cognitive function, our targeted group was those of the elderly who still had the opportunity to perform regular low intensity physical activity.

Chosing variables for a study of an old population is a challenge, with most indicators having their own advantages and drawbacks.[8 9] The validity of variables such as income, education, and fortune may be discussed, but we believe including all three of them gave us a broad picture of the current socioeconomic situation of the elderly. In this study we used self perceived safety as the equivalent to fear of crime, and as the individual level antagonism to police registered neighbourhood violence. Questions can be raised as to whether this variable captures the fear of crime, rather than just poor health, hearing, and eyesight problems, or any other impetus towards physical inactivity.[31] Questions can also be raised regarding the validity of measuring fear of crime by a variable indicating fear of walking in the neighbourhood in the evening, when it is probable that most of the elderly's outdoor activities are performed during the day. We do not know how accurately self perceived safety after dark among the elderly corresponds with the perception of safety during the day. But we do not believe that there would be substantial changes in distributions of expression of low self perceived safety had it been measured at daytime, albeit the fear level most probably would be somewhat lower during the day.

Physical activity was measured by a one question item that has to our knowledge not been validated. We do find, however, our variable to be sufficiently suitable for our purpose. Measuring physical activity in large, population based studies usually relies on questionnaires, in which moderate activities such as walking may be reported less accurately than vigorous activities such as jogging or swimming that are planned and structured,[38] and which are typically included in validated measures of physical activity, but not necessarily relevant in analyses of the elderly.

Statistically, we chose to dichotomise all variables to measure whether there were significant associations or not, but by specifying only two categories for each variable, some of the finer relations between the independent variables and physical activity may remain obscured. Any evidence of causality could not be obtained from our cross sectional study.

In conclusion, this study has shown that differences in health between neighbourhoods do not explain differences in physical activity between neighbourhoods. These neighbourhood differences are better explained by neighbourhood violence (for men), socioeconomic variables and self perceived safety (for women).

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