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Physical activity, muscular strength, and polypharmacy among older multimorbid persons: Results from the KORA-Age study

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The purpose of this study was to examine whether physical activity (PA) and muscular strength (MS) are related to polypharmacy. Our cross-sectional analysis was based on 711 patients with multimorbidity (MMB), aged 65-94 years, who participated in the KORA-Age study. Participants underwent a face-to-face interview and extensive physical examinations including anthropometric measurements, registration of chronic diseases, determination of health-related behaviors (smoking, alcohol intake, physical activity, etc.), collection of blood samples and measurement of hand-grip strength. PPha was defined as the use of >4 drugs and MMB as having ≥2 of 13 chronic diseases. Prevalence of PPha was 44.6% (n=317), and a significant difference was found in the number of drugs used between participants with and without PPha (7.2±2.1 vs 2.5±1.2, $P<.001$). Patients in the lower compared to the upper tertile of physical activity had a significantly increased odds to be on PPha (OR: 1.64, 95% CI: 1.05-2.56, $P=.031$) after controlling for age, gender, BMI, family status, education, alcohol intake, smoking habits, number of diseases, hs-CRP, and telomere length. On the contrary, no significant association between muscular strength and PPha was found (OR: 1.04, 95% CI: 0.66-1.63, $P=.873$) after multivariable adjustment. Among older persons with MMB, lower levels of physical activity, but not low muscular strength, are associated with higher odds of PPha. Increasing the levels of physical activity appears to be highly recommended in order to potentially reduce the risk of PPha among multimorbid persons aged 65 and older.

KEYWORDS
multimorbidity, muscular strength, physical activity, polypharmacy

1 | INTRODUCTION

Polypharmacy (the use of more medications than clinically required) is very common among older adults and is associated with increased medical costs and adverse health outcomes such as functional decline, falls, hospitalizations, and mortality.[1,2] In prior studies, the prevalence of polypharmacy (PPha), usually defined as receiving four or more medications, ranged between 44% and 86%[3-5] and known risk factors for PPha include higher age, poorer health status, lower education and income, and some sociodemographic characteristics such as race and ethnicity.[6,7]

Other factors, however, such as physical activity or muscular strength levels may also be associated with polypharmacy. It is well documented that regular physical activity protects against several chronic diseases and reduces the risk of premature mortality[8,9] and such a strong relationship between muscular weakness, physical disability, and mortality has also been recently reported.[10,11] In addition, new scientific evidence suggests that exercise training and many drugs have comparable effectiveness regarding their mortality reduction in several chronic diseases such as coronary artery disease, stroke, impaired glucose tolerance, and dyslipidaemia.[12-14] Given that the skeletal muscle is the largest organ in the human body which is confrontated with the catabolic effects of aging, it is of vital importance for elderly people to maintain sufficient levels of physical activity and muscular strength in order to reduce their morbidity and mortality risk. Based on this scientific background, it is interesting to examine whether physical activity and muscular strength are associated with PPha in the elderly; however, data from population-based studies addressing this issue are scarce.[2,7]

Husson et al.[7] showed that among community-dwelling people aged 60 years and older, a lack of physical activity was one of six independent variables associated with PPha, whereas Sganga et al. reported that among older adults admitted to acute care hospitals, those in the highest tertile of handgrip strength had a significantly lower likelihood of polypharmacy after adjusting for potential confounders. However, there are some critical points in the above studies. In the study of Sganga et al.[2] only in-hospital patients were included and the focus was on excessive PPha (defined as the concomitant use of ten or more medications), whereas Husson et al.[7] adjusted only for metabolic syndrome and not for other diseases in their analysis. Therefore, there is a need to further explore the association of physical activity and muscular strength with PPha, especially among elderly persons with multiple chronic diseases as multimorbidity per se has a negative impact on both physical function and polypharmacy as well. Moreover, comparative studies on the association between these two "risk factors" and multiple drug intake among patients with multimorbidity are missing.

Thus, the aim of this study was to examine whether physical activity and muscular strength are associated with polypharmacy in a large population-based sample of elderly men and women aged 65-94 years. We hypothesized that elderly, multimorbid people with reduced physical activity and muscular strength levels have higher odds to be on PPha irrespective of other cofactors.

2 | METHODS

2.1 | Study population

Data were collected in 2009 during the KORA (Cooperative Health Research in the Region of Augsburg)-Age study, a follow-up study of the four MONICA/KORA Augsburg Surveys. The KORA-Age study population consisted of a subgroup of 5991 individuals who were born in 1944 or earlier. In total, 4127 individuals participated in a standardized telephone interview (response 67%). Out of this group, a randomly drawn sample of 1079 participants additionally underwent extensive physical examinations including the registration of medication, collection of blood samples, assessment of anthropometry, physical function measurements, and an additional interview among others. The analysis was restricted to multimorbid (defined as having two of 13 chronic diseases) persons aged 65-94 years (n=733). After exclusion of participants with incomplete data on all required variables (n=22), 711 persons remained for the final analysis. The KORA-Age study was approved by the Ethics Committee of the Bavarian Medical Association. Written informed consent has been obtained from the participants, and all investigations have been conducted according to the principles expressed in the Declaration of Helsinki.

2.2 | Data selection

2.2.1 | Multimorbidity definition

The presence of chronic health conditions was self-reported by the participants in a self-administered questionnaire and the standardized telephone interview. In the questionnaire, the participants were asked whether they were ever diagnosed with a myocardial infarction, hypertension, stroke, diabetes mellitus, or a malignant disease. In addition, participants should indicate whether they had a coronary artery bypass graft surgery or received a coronary artery stent.

The telephone interview was based on the Charlson Comorbidity Index[15] The participants were requested to indicate whether they currently have asthma, emphysema, or chronic obstructive pulmonary disease, an inflammatory joint disease (eg, arthritis) or a rheumatic disease, a gastrointestinal disease (eg, gastric or duodenal ulcer, colitis, cholecystitis), heart complaints (eg, angina pectoris, heart failure, coronary

heart disease), a kidney disease, or a liver disease (eg, cirrhosis). In addition to the disorders covered by the Charlson Comorbidity Index, we asked for the presence of neurologic diseases such as multiple sclerosis, Parkinson′s disease, or epilepsy, whether the participant has or had a glaucoma or cataract, and finally we requested the presence of any other disease which has not been mentioned before. Depression was assessed using the Geriatric Depression Scale (GDS-15)[16] Scores above 10 points were considered as having depression. The presence of an anxiety disorder was assessed using the Generalized Anxiety Disorder Scale-7 (GAD)[17] Scores >10 points indicated the presence of an anxiety disorder. An eye disease was deemed to be present if participants indicated to have glaucoma or cataract or other eye diseases such as macular degeneration, diabetic retinopathy, and retinitis pigmentosa. Each single response to the open question on other diseases was checked. If they contained information regarding the above-mentioned conditions, the presence of the condition was modified accordingly. According to the available information on diseases, 13 conditions were defined (Table 1). Multimorbidity was defined as the co-occurrence of two or more of these conditions within one person.[18]

2.2.2 | Polypharmacy definition

Use of medication and supplements was collected through a database supported computer software (IDOM: Instrument for data based assessment of medication).[19] All medications were classified in the database according to the international Anatomical Therapeutic Chemical Classification System (ATC) of the WHO Collaborating Centre for Drug Statistics Methodology (http://www.whocc.no/atc_ddd_index/). Participants were asked to bring all product packages of ingested medications and supplements to the study center. The inquiry period covered the last 7 days prior to the interview and participants' mode of ingestion (regularly or irregularly, ie, as needed), mode of prescription (prescribed, recommended by physician, self-medication), dosage, and frequency of ingestion were collected for each preparation. For the present analysis, the variable "number of drugs" includes only regularly consumed drugs prescribed by a physician. Dietary supplements and herbal products as well as homeopathic preparations were not considered. Polypharmacy was defined as the use of >4 drugs taken on a daily basis.

2.2.3 | Physical activity and muscular strength assessment

Physical activity was assessed with the Physical Activity scale for the Elderly (PASE), an established 12-item questionnaire for measuring self-reported physical activity in three life domains (leisure, household, and occupational activity) among older adults. Then, a continuous physical activity score was calculated (PASE total) and regarded in this analysis[20]. The higher the mean total score, the higher the physical activity. Grip strength was measured in kilograms (kg) using a hand-held dynamometer (JAMAR, Lafayette Instrument, Loughborough, UK). After adjustment for hand size, three attempts were performed with the dominant hand and all three measurements were averaged for the analysis. In our sample, we had a high prevalence of joint diseases (25.3%) as well as stroke patients (12.8%) and 15% of very old participants aged 85 years and over; thus, we decided to use three efforts to ensure that the "true" maximal value was obtained.

2.2.4 | Covariates

Covariates included age, gender, body mass index (BMI), family status, education, alcohol intake, smoking habits, number of chronic diseases, serum levels of high sensitive (hs)-C-reactive protein (hs-CRP), and leukocytes telomere length. Anthropometric measurements were taken after the participants had removed their shoes, heavy clothing, and belts. Body height was measured to the nearest 0.1 cm and weight to the nearest 0.1 kg. BMI was calculated as weight (in kilograms) divided by height (in square meters). Each participant was questioned regarding his or her family status. The questionnaire consisted of a six-category answer: (a) unmarried, living alone, (b) unmarried, living with a partner, (c) married, living with the partner, (d) married, living apart, (e) divorced, and (f) widowed. Education was dichotomized into low (≤10 years of education) and high educational level (≥11 years of education). Assessment of alcohol intake (in grams per day) was based on data regarding weekday and weekend consumption of beer, wine, and spirits. Participants provided information about their smoking habits and were classified into two groups: current and ex-smokers vs never smokers.

A non-fasting venous blood sample was obtained from all study participants while sitting and hs-CRP was measured by nephelometry (BN II; Siemens, Eschborn, Germany). Inter- and intra-assay coefficients of variation were <6% and <5%, respectively. Leukocyte telomere length measurements were made using a quantitative PCR assay comparing a TL PCR product (T) against a PCR product of a reference (S) gene to produce a T/S ratio as described in detail elsewhere.[21] In brief, DNA samples were run in duplicate in 25 μL reactions using a CAS-1200 liquid handling system (Qiagen, Manchester, UK) and run on a Rotorgene-Q Real Time Thermal Cycler (Qiagen). The single copy gene used was *36B4*. Alongside the samples, each run also contained a Calibrator sample (DNA from the K562 cell line) in duplicate and a no template control. Analysis of the PCR output was performed using Comparative Quantification (Qiagen Rotorgene analysis software, Qiagen), and quantification is relative to the calibrator DNA. Samples were checked for concordance between

TABLE 1 Assessment of diseases in the KORA-Age Study

Self-report generated Charlson Comorbidity Index	Kora-Age study	Method
Asthma, emphysema, or chronic bronchitis	√	Telephone interview
Arthritis or rheumatism	√	Telephone interview
Cancer, diagnosed in the past 3 y	√	Questionnaire
Diabetes	√	Questionnaire
Digestive problems (such as ulcer, colitis, or gallbladder disease)	√	Telephone interview
Heart diseases (such as angina, congestive heart failure, or coronary artery disease)	√	Questionnaire, telephone interview
Kidney disease	√	Telephone interview
Liver problems (such as cirrhosis)	√	Telephone interview
Stroke	√	Questionnaire
HIV illness or AIDS	--	Not requested
	Neurologic diseases such as multiple sclerosis, Parkinson′s disease, or epilepsy	Telephone interview
	Eye diseases such as glaucoma, cataract, macular degeneration, diabetic retinopathy, or retinitis pigmentosa	Telephone interview
	Hypertension	Questionnaire
	Depression	Geriatric Depression Scale (GDS-15) administered via telephone interview
	Anxiety	Generalized Anxiety Disorder Scale-7 (GAD) administered via telephone interview

duplicate measurements and to ensure that they ran within the established linear range of the assay. In addition, to ensure reproducibility of the assay, samples were re-run at random on different days. Using this method, inter-run coefficients of variation were between 2.7% and 3.9%.

2.3 | Statistical analysis

Means and frequencies were used to describe demographic and other clinical characteristics of the study population at baseline and differences between persons with and without polypharmacy were analyzed using the *t* test for independent samples or the chi-square test (for continuous and categorical variables, respectively). Pearson′s correlation tests were used to evaluate the correlations between number of medications and both muscular strength and total physical activity score; ANCOVA (using age and gender as covariates) and the Bonferroni post hoc test were applied to test for differences in the number of medications across the incremental tertiles of both physical activity and muscular strength.

Logistic regression was performed to determine the association between polypharmacy (yes/no) and tertiles of physical activity and muscular strength (using gender-specific tertiles). Firstly, unadjusted models were calculated (Model 1) and then analyses were adjusted for age and gender (Model 2) BMI, family status, education, alcohol intake, and smoking habits (Model 3) and finally also for number of diseases, hs-CRP, and telomere length (Model 4). We performed the

logistic regression with the same models separately for physical activity and muscular strength. Statistical analyses were performed using the SPSS program (version 16.0, SPSS Inc, Chicago, Illinois, USA), and the level of statistical significance was set at $P<.05$.

3 | RESULTS

The characteristics of the participants with and without polypharmacy are shown in Table 2. Patients with PPha were significantly older, had a higher BMI and poorer physical activity score, were more likely to be smokers, had slightly increased hsCRP-levels, took three times more medications, and had a higher number of chronic diseases. Differences are particularly apparent for heart and lung diseases and diabetes.

The prevalence of PPha among our participants was 44.6%. Table 3 presents the most common drug classes, classified by ATC codes, received by our participants. The most frequently used medications were diuretics (56.8%), beta-blockers (47.8%), and ACE-inhibitors (41.1%) followed by antiplatelet drugs (39.7%) and statins (30.9%). Total physical activity score was inversely correlated with the number of medications ($r=-.200$, $P<.001$) but muscular strength was not ($r=-.046$, $P=.229$).

Furthermore, we tested for differences in the number of medications used across the incremental tertiles of both physical activity and muscular strength. The ANCOVA analysis showed a significant association with physical activity. After adjusting for age and gender, those in the lowest tertile of physical activity received significantly more medications but this was not the case for muscular strength (Figure 1).

Physical activity was strongly associated with PPha (Table 4). The age- and gender-adjusted logistic regression analysis (Model 2) showed that low levels of physical activity were associated with a twofold increased odds to be on PPha (OR: 2.14, 95% CI: 1.43-3.21, $P<.001$). When the models were further adjusted for BMI, family status, education, smoking habits, and alcohol intake (Model 3), the associations still remained significant (OR: 1.85, 95% CI: 1.22-2.83, $P<.01$). After final adjustment for number of medications, hs-CRP, and telomere length (Model 4), the odds was only slightly attenuated (OR: 1.64, 95% CI: 1.05-2.56, $P<.05$).

TABLE 2 Characteristics of participants according to polypharmacy status (means±SD)

	No polypharmacy (n=394)	Polypharmacy (n=317)	*P*-value
Age (y)	76.5±6.4	77.8±6.3	<.001
Male (%)	46.2	49.2	.423
Weight (kg)	75.2±13.2	78.8±15.4	<.010
Height (cm)	163.0±9.5	163.4±9.4	.571
BMI (kg/m^2)	28.2±4.1	29.5±4.9	<.001
Higher education (%)	31.8	31.0	.515
Current and ex-smokers (%)	38.3	49.2	<.010
Alcohol intake (g/d)	11.8±16.8	10.8±17.2	.436
PASE total score	118.1±53.7	98.8±50.9	<.001
Hand-grip strength (kg)	25.6±9.9	24.9±9.6	.392
Number of drugs	2.5±1.2	7.2±2.1	<.001
hs-CRP, median (IQR), pg/mL	1.64 (0.84-3.69)	2.19 (1.05-4.80)	<.010
Telomere length (No)	1.49±0.3	1.47±0.2	.352
Diseases (%)			
Heart diseases	31.2	57.7	<.001
Eye diseases	60.2	50.8	.570
Diabetes	16.8	34.7	<.001
Joint disease	23.4	27.8	.179
Lung diseases	11.9	18.0	<.050
Depression	13.3	11.9	.592
Kidney disease	5.3	8.5	.092
Cancer	5.3	5.7	.824

IQR, interquartile range; PASE, physical activity scale for the elderly.

TABLE 3 Medication categories most commonly used by the participants

Medications	ATC codes	n
Diuretics	C03, C07BB, C07C, C09BA, C09DA, C02LA01, C07FB03	404
Beta-blockers	C07	340
ACE-inhibitors	C09A, C09B	292
Antiplatelet drugs	B01AC	262
Statins	C10AA, C10BA02	220
Calcium channel-blockers	C08, C09DB, C09BB	198
Thyroid drugs	H03AA, H03BB01	164
Oral antidiabetics	A10B	120
Anticoagulants	B01AA, B01AB	78
Corticosteroids[a]	H02, D07, A01AC, A07EA, C05AA, S01BA, S02B, S03C,	68
Antidepressants	N06AA, N06AB, N06AF, N06AG, N06AX	56
Insulin therapy	A10A	44
Estrogens[b]	G03C, G03F	32
Cardiac glycosides	C01A	22
Anti-dementia drugs	N06DA, N06DX, N06BX	21

[a]Included were dermatological and locally acting medications.
[b]Included were also medications indicated for menopausal symptoms.

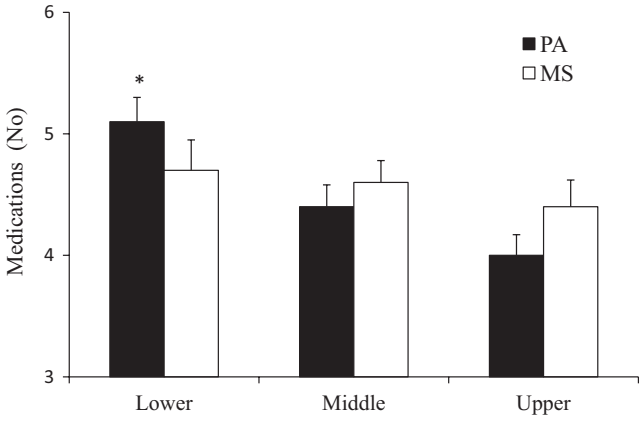

FIGURE 1 Received medications according to the tertiles of physical activity (PA) and muscular strength (MS) after adjusting for age and gender, *P<.05 vs middle and upper tertile, in parenthesis the mean values for the physical activity and mascular strength group (5.1, 4.4, 4.0, and 4.7, 4.6, 4.4 for lower, middle, and upper tertile, respectively; error bars represent standard errors values)

Muscular strength was also inversely related to PPha in the unadjusted analysis (Model 1). However, we did not find a significant association between muscular strength and PPha after multivariable adjustment (Table 4).

4 | DISCUSSION

To our knowledge, this is the first population-based study demonstrating that low physical activity but not muscular strength is inversely associated with polypharmacy among older patients with multimorbidity. This association was independent of confounders including the number of diseases, hs-CRP, and telomere length.

Known risk factors for PPha include increased age, poorer health status, lower education and income, and some sociodemographic characteristics such as race and ethnicity.[6,7] However, the link of PPha to physical activity and muscular strength has received little attention so far. In two recent studies, a significant association between PPha and lack of physical activity[7] as well as low levels of muscular strength has been reported in older adults[22]. In the study of Sganga et al.[22] participated only in-hospital patients and the focus was on excessive polypharmacy (the use of ten or more medicines), whereas Husson et al.[7] recruited older adults from the general population and adjusted only for metabolic syndrome and not for other diseases in their analysis. Therefore, there is a need to further explore the role of physical activity and muscular strength with respect to polypharmacy risk, especially among elderly patients with multiple chronic diseases as multimorbidity per se has a negative impact in both physical function and polypharmacy as well. We extended the above findings further, comparing the role of these risk factors with respect to polypharmacy among elderly persons with multimorbidity. According to our results, physical activity seems to be closer associated with PPha than muscular strength among persons who suffer from multiple chronic diseases and to our knowledge, this is the first study nowadays presented on this topic.

In our analysis, we adjusted for several established confounders and further for the number of diseases, inflammatory

TABLE 4 Odds ratios and 95% CI for polypharmacy by tertiles of physical activity and muscular strength

Polypharmacy (use of >4 drugs)					
	Lower	*P*	Middle	*P*	Upper
Tertiles of physical activity					
Model 1	2.27 (1.55-3.34)	<.001	1.40 (0.93-2.10)	.106	1.00 (Referent)
Model 2	2.14 (1.43-3.21)	<.001	1.35 (0.89-2.04)	.157	1.00 (Referent)
Model 3	1.86 (1.22-2.83)	.004	1.23 (0.81-1.88)	.334	1.00 (Referent)
Model 4	1.64 (1.05-2.56)	.031	1.28 (0.82-2.01)	.269	1.00 (Referent)
Tertiles of muscular strength					
Model 1	1.47 (1.01-2.13)	.042	1.36 (0.92-2.00)	.126	1.00 (Referent)
Model 2	1.23 (0.82-1.86)	.316	1.24 (0.83-1.86)	.279	1.00 (Referent)
Model 3	1.18 (0.77-1.81)	.435	1.27 (0.85-1.92)	.249	1.00 (Referent)
Model 4	1.04 (0.66-1.63)	.873	1.25 (0.81-1.94)	.311	1.00 (Referent)

Model 1: unadjusted; Model 2: adjusted for age and gender; Model 3: in addition to model 2 further adjusted for BMI, family status, education, alcohol intake, and smoking status; Model 4: in addition to model 3 further adjusted for number of diseases, hs-CRP, and telomere length.

status, and telomere length because these factors may significantly affect the medication use of older people. After the final adjustment (Model 4), we still found a 1.64 times higher odds to be on PPha for those who were in the lowest tertile of physical activity. This is a novel and important finding and underscores the autonomous protective effects of physical activity against the risk of PPha.

The observed strong association between physical activity and PPha can be explained by several facts reported in the literature. Regular performed physical activity can counteract the age-related decline in several physiologic functions protecting by this way against chronic diseases and multimorbidity as well.[8,9] Recent evidence also suggests that exercise training and many drugs have comparable effectiveness regarding their mortality reduction in several chronic diseases.[12-14] In addition, among individuals with cardiovascular and metabolic diseases systematic exercise reduce the medications needed for disease treatment (eg, trained patients with hypertension, coronary artery disease, or diabetes);[23,24] exercise training also decreases platelet aggregation and coagulation and increases fibrinolysis in healthy people as well as patients with cardiovascular disease.[25] In particular for older adults, the pharmacological properties of regular physical activity are further translated to an improved cognitive function and a reduced risk of neurodegenerative diseases (eg, dementia, Alzheimer′s or Parkinson's disease)[26,27]; finally, systematic exercise has recently been recognized as one of the best ways to prevent and treat the age-associated frailty-syndrome[28] Based on the above findings, it can be expected that there is a strong association between the level of physical activity and the medication use among older multimorbid adults; indeed, according to our results the lower the physical activity the higher the likelihood to be on PPha.

In our study, we found that there are differences between physical activity and muscular strength regarding their association to polypharmacy. For this, the following explanations can be assumed: There were no differences in muscular strength between persons with and without polypharmacy and the correlation between muscular strength and polypharmacy was also very poor. Furthermore, in the ANCOVA analysis (Figure 1), we found no significant differences in the received medications between the strength tertiles (4.7 vs 4.4 medications from the lowest to the highest third). Another explanation is the test we used for the assessment of muscular strength (hand-held dynamometry might not necessary represent total body strength or lower body strength). For this reason, we searched the literature for studies using both grip strength and lower body strength to compare their effectiveness regarding a clinical endpoint (in our case mortality outcome). We found that in the majority of studies grip strength provided risk reductions similar[29-31] or somewhat worse[32] to those of quadriceps/knee extensor strength (hazard ratios for grip studies ranged between 1.10 and 1.86 vs 1.36-2.52 for lower body strength). Thus, although not the optimal mean, it seems that grip test can be used as a good test to detect associations with clinical parameters or as a prognostic marker in population-based studies. Another reason was the fact that we had a high prevalence (25.3%) of joint diseases in our sample (patients with arthritis or rheumatism can produce less hand-grip strength).

Prior studies were inconsistent regarding the use of hand-grip strength measurements in their analysis. Some studies used average grip strength[32] and other ones maximal grip strength.[30] In the present study, which included old and very old as well as a great proportion of chronically ill persons we averaged three efforts of hand-grip measurements to account for the possibly greater individual variation in this group.

Thus, the average result may be lower than the "true" maximum of grip strength. It could be assumed that, when using the best measurement of the three attempts the association between grip strength and polypharmacy would be somewhat stronger. In our study, there was no significant association between grip strength and polypharmacy in multivariable analysis (*P*-value .873). It seems very unlikely that the association between muscular strength and polypharmacy became significantly related using maximal grip strength in the models.

However, given that there is increasing evidence of the potential benefits of maintaining and improving muscle mass and strength with respect to treating chronic diseases and reducing morbidity and mortality[10,11,33] more studies are needed to clarify whether muscular strength is associated with polypharmacy among older multimorbid adults.

4.1 | Limitations

We were not able to determine the underlying mechanisms of the reported associations between physical activity, muscular strength, and polypharmacy because of the cross-sectional character of our study. Although we adjusted for several confounders, it may be that other, unmeasured factors might have affected the observed associations. Another limitation is that muscular strength, although assessed using a validated methodology, did not accurate measures the individuals′ total body strength. Another limitation is that muscular strength, although assessed using a validated methodology, did not accurate measures the individuals′ total body strength. Thus, more studies using overall muscle strength measures with a prospective design are needed to clarify this topic.

5 | PERSPECTIVES

Our findings have important practical implications targeting elderly people who suffer from multimorbidity. Given that sedentary behavior is a modifiable risk factor, it is of great interest for older adults to improve their levels of physical activity. From a public health perspective, a sufficient level of physical activity, as currently prescribed by numerous health organizations[34,35] is essential not only to improve fitness and other health-related parameters but also to reduce the likelihood to be on polypharmacy among those who suffer from multiple chronic diseases. As polypharmacy is a common characteristic among older adults associated with many adverse health outcomes, more studies are required to further assess the impact of different aspects of physical activity (eg, types and/or intensity of the activities) on polypharmacy risk.

We found that physical activity, but not muscular strength, is inversely and independently associated with polypharmacy among older adults from the general population who suffer from many chronic diseases (multimorbidity). Thus, multimorbid persons should be encouraged to enhance their physical activity levels in order to reduce their need for multiple drug intakes.

COMPETING INTERESTS

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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