European Journal of Public Health, 1–7

doi:10.1093/eurpub/ckab113

Mediterranean diet, walking outdoors and polypharmacy in older patients with type II diabetes

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Background: Polypharmacy and its adverse health effects is an emerging public health issue, with increasing prevalence among patients with multiple chronic conditions, such as older adults with diabetes. A healthy lifestyle has been shown to improve both diabetes and polypharmacy incidence. We conducted a cross-sectional study to investigate the association of a healthy lifestyle with polypharmacy and comorbidities in older people with diabetes. **Methods:** All out-patients from January 2013 to June 2015 with type II diabetes aged 65 years or more from a Lazio Region reference centre for diabetes were included in the study. Socio-demographic, clinical and lifestyle data were collected from medical records and through face-to-face standardized questionnaires. The comorbidity-polypharmacy score (CPS) was used to characterize the overall patients' frailty, by assessing concurrently the presence of comorbidities and polypharmacy. The cumulative logit model was used to estimate odds ratios (ORs) and 95% confidence intervals (CIs). **Results:** Adjusted ORs for age, sex, body mass index, physical activity and cognitive status, showed that CPS score was inversely related to weekly consumption of cruciferous vegetables (OR: 0.56, 95% CI: 0.35–0.90; *P*-trend = 0.015), leafy green vegetables (OR: 0.54, 95% CI: 0.33–0.87; *P*-trend = 0.013) and daily intake of fruits (OR: 0.63, 95% CI: 0.41–0.97; *P*-trend = 0.036). Walking outdoors was found inversely related to CPS score (age- and sex-adjusted OR: 0.60, 95% CI: 0.42–0.86). **Conclusion:** Our findings suggest that eating some dietary factors present in the Mediterranean diet and walking outdoors regularly is associated with a lower intensity of medicines need to treat comorbidities among older people with diabetes.

Introduction

Older people have the highest burden of illness, which require drug-based interventions to prevent and treat multiple health conditions.[1] It has been estimated that circa 20% of people over 70 years old take five or more drugs concomitantly.[2] Polypharmacy, the use of multiple medicines concurrent to treat multimorbidity, is associated with adverse drug events, such as skin reaction, falls, hospitalization and death.[2,3] The risk of adverse effects associated with polypharmacy increases with age since physiological changes, such as decreased renal clearance and decreased hepatic enzymes activity occur.[4] Diabetes is very common in old age, with prevalence reaching 24.2%.[5] Polypharmacy is highly prevalent among people with diabetes since the management of diabetes is complex.[6] It includes not only glycaemic control but also the prevention of cardiovascular and microvascular complications.[7] It has been suggested that almost half of the elderly people with type 2 diabetes mellitus (48%) take 9 medications or more daily.[8]

Intervention studies suggest that incidence of diabetes can be decreased by lifestyle changes (e.g. diet, smoking cessation, physical activity) in subjects with impaired glucose intolerance.[9] The consumption of some food components of the Mediterranean diet, such as vegetables, nuts and fish has been associated with a decreased risk of diabetes.[10] They seem to exert beneficial effects on blood pressure, modulate insulin resistance, improve atherogenic dyslipidaemia and decrease inflammatory burden.[11]

A healthy lifestyle has been shown to attenuate the effects of polypharmacy on mortality among older adults in the general population.[12] However, no study yet has been conducted to investigate if lifestyle is associated with a lower level of polypharmacy among older people with diabetes. Thus, the objective of this study was to investigate the association of a healthy lifestyle, in particular, Mediterranean diet and physical activity, with polypharmacy levels in older people with diabetes.

Methods

The study was conducted in a reference centre for diabetes of the Lazio Region (San Camillo Hospital, Rome). All outpatients during the period January 2013 to June 2015 with type II diabetes and aged 65 years and more were invited to participate in the study ($N = 503$). The study protocol was approved by the Local Health Authority Rome 3 ethics committee and written consent was obtained from all participants. Trained medical personnel collected clinical data and administrated a standardized questionnaire to the subjects. The following information was collected: sociodemographic data, smoking history, dietary habits, physical activity, cognitive function and depression symptoms. The presence of comorbidities was collected from medical records. The use of medicines was initially gathered from clinical records and then the subjects were asked to confirm their use.

A validated weekly semiquantitative food-frequency questionnaire (36 items) was used to assess food intake.[13]

Body mass index (BMI) was calculated by using physical measurements of body height and weight. The Abbreviated Mental test was used to assess cognitive function, with a score of less than seven suggesting abnormal cognitive function. The Geriatric Depression Scale was used to detect symptoms of depression using a threshold of 7 or more of the 15 items.[14]

The physical activity questionnaire was an adaptation of the Voorrips questionnaire[15] and was used in a study published elsewhere.[16] The variable physical activity was categorized as follows: (i) walking outdoors 3 times weekly or less for at least 15 min; (ii) walking outdoors 4 times or more weekly for at least 15 min.

Current smokers were defined as those who smoked at least one cigarette per day or had stopped smoking cigarette during the past 12 months. Former smokers were defined as those who previously smoked but had quit smoking for more than 12 months. Both former and current smokers constituted the group of ever smokers.

Since the social context in which older people live may influence indirectly polypharmacy, data was also collected regarding this aspect. A variable defined as residence status was created as following: living at home with the spouse/partner or other relatives; living at home alone; living in an elderly care institution.

The comorbidity-polypharmacy score (CPS)[17,18] was used in the study population to characterize the overall patients' frailty, by assessing concurrently the presence of chronic conditions and the number of drugs need to treat them (polypharmacy). The CPS index, used in literature as an independent predictor of health outcomes, such as mortality or complications in hospital settings,[19,20] is defined as the sum of the number medications and all known comorbidities; participants were grouped into three score categories: mild (CPS: 0–7), moderate (CPS: 8–14) and severe (CPS: ≥15).

Statistical analysis

Univariate and multivariate odds ratios (ORs) and 95% confidence intervals (CIs) for potential factors associated with polypharmacy and comorbidities were estimated using the ordered logit model, using the CPS categories as the dependent variable. The ordered logit model is a direct extension of the usual logistic regression model, allowing for the analysis of polytomous ordinal dependent variables, but rather than applying the logit transformation to the binary response probabilities $P(Y = 1|x)$, it applies it to the cumulative response probabilities $P(Y \leq yj|x)$. The estimates derived from

Table 1 Socio-demographics, anthropometric and clinical characteristics of the 490 subjects with diabetes and their association with comorbidity-polypharmacy score

	Study base (*N* = 490)		
Characteristics	*N* (%)[a]	OR[b,c] (95% CI)	*P*
Sex			
Males	263 (53.7)	1	
Females	227 (46.3)	1.59 (1.12–2.25)	0.009
Age, years			
65–74.9	255 (52.0)	1	
≥75	235 (48.0)	2.15 (1.51–3.05)	<0.0001
Education			
<6	195 (40.1)	1	
6–8	121 (24.9)	0.73 (0.47–1.15)	0.173
9–13	131 (27.0)	0.85 (0.55–1.32)	0.466
>13	39 (8.0)	0.73 (0.37–1.42)	0.355
Residence status			
At home with spouse or relatives	385 (78.7)	1	
At home alone	101 (20.7)	1.19 (0.77–1.84)	0.440
In an institution	3 (0.6)	1.46 (0.18–11.9)	0.723
Duration of diabetes, years			
<10	198 (41.0)	1	
10–19	165 (34.2)	1.26 (0.84–1.88)	0.266
≥20	120 (24.8)	1.58 (1.00–2.48)	0.051
Body mass index (kg/m^2)			
Low (<25)	147 (30.1)	1	
High (≥25)	341 (69.9)	1.68 (1.14–2.47)	0.008
Cognitive function (score)			
Normal	468 (96.1)	1	
Abnormal[d]	19 (3.9)	2.84 (1.14–7.07)	0.025
Depressive symptoms			
No	221 (45.4)	1	
Yes[e]	266 (54.6)	1.15 (0.81–1.63)	0.433
Ever smoking			
No	209 (42.7)	1	
Yes	281 (57.3)	1.11 (0.76–1.61)	0.594
Walking			
Low (<4 times weekly)	262 (53.5)	1	
High (≥4 times weekly)	228 (46.5)	0.60 (0.42–0.86)	0.005
Number of comorbidities			
Mean (SD)	5.7 (2.8)		
Median (IQR)	5 (4–7)		
Number of drugs used			
Mean (SD)	6.1 (2.6)		
Median (IQR)	6 (4–8)		
Comorbidity-polypharmacy score			
Mild (0–7)	88 (18.0)		
Moderate (8–14)	275 (56.1)		
Severe/morbid (≥15)	127 (25.9)		

OR, odds ratio; CI, confidence interval; SD, standard deviation; IQR, interquartile range.
a: Totals may vary because of missing values.
b: Estimated by ordered logit model.
c: OR adjusted for age and sex.
d: Six or less in mental test score.
e: Seven or more symptoms of GDS-15 scale.

this model (exp β) can be viewed as a summary OR that is independent of the cut-off points used to classify the outcome:

the interpretation of the OR for a given variable is the expected increase in the log odds of being in a higher level of CPS for a one unit increase in that variable, while the other variables in the model are held constant. The Likelihood ratio test was used to decide whether keeping or not each covariate in the model. The levels of intake of the dietary variables were included as ordinal variables in the model, in order to test for trend (Wald test). Statistical analyses were performed using the statistical software package STATA, release 15.[21]

Results

Out of 503 patients, 490 completed the interview (97.4%). Of the 490 older people with type II diabetes [mean age, 75.1 years; standard deviation (SD) = 6.1], 53.7% were men and 46.3% were women, and the mean duration of diabetes was 13.9 years (SD = 10.3). The mean number of medicines used concomitantly by participants was 6.1 (SD = 2.6). The mean number of comorbidities in the participants was 5.7 (SD = 2.8). In our study, 88 subjects (18.0%) had a mild CPS (0–7), 275 subjects (56.1%) had a moderate CPS (8–14) and 127 subjects (25.9%) had a severe CPS ≥15. The number of drugs and number of comorbidities by CPS categories are shown in the supplementary table S1.

Table 1 reports the associations between socio-demographic characteristics, smoking, BMI, physical activity, clinical characteristics and the CPS. Subjects with 75 years or more (OR: 2.15, 95% CI: 1.51–3.05) and with a BMI of 25 or more (OR: 1.68, 95% CI: 1.14–2.47) had higher CPS in comparison to older people with <75 years and with a lower BMI, respectively. Females showed a higher CPS in comparison to males (OR: 1.59, 95% CI: 1.12–2.25). Subjects with altered cognitive status (<7) are more than 2-fold likely to have a higher CPS (OR: 2.84, 95% CI: 1.14–7.07). Duration of diabetes ≥20 years (OR: 1.58, 95% CI: 1.00–2.48) was borderline associated with CPS. Walking regularly (≥4 times weekly) for at least 15 min was inversely associated with CPS (OR: 0.60, 95% CI: 0.42–0.86). Education, residence status, smoking and the presence of depression symptoms were not associated with CPS.

Table 2 depicts the association between the intake of plant origin foods and the CPS. High consumption of salad (≥ 3 times weekly) (OR: 0.70, 95% CI: 0.49–1.00), and medium (3–4 times weekly) and

Table 2 Weekly consumption of plant origin foods and categories of comorbidity-polypharmacy score

Characteristics	Study base (*N* = 490) *N* (%)[a]	OR[b,c] (95% CI)	*P*	OR[b,d] (95% CI)	*P*	P_{trend}[e]
Cooked vegetables						
Up to 2 times/week	155 (31.6)	1		1		
3–4 times/week	160 (32.7)	0.59 (0.38–0.90)	0.016	0.60 (0.39–0.93)	0.023	0.008
≥5 times/week	175 (35.7)	0.53 (0.35–0.82)	0.004	0.55 (0.36–0.85)	0.007	
Salad						
Up to 2 times/week	207 (42.3)	1		1		
≥3 times/week	282 (57.7)	0.70 (0.49–0.99)	0.045	0.70 (0.49–1.00)	0.050	
Cruciferous vegetables						
Less than weekly	166 (34.0)	1		1		
1–2 times/week	202 (41.3)	0.74 (0.49–1.10)	0.137	0.72 (0.48–1.09)	0.119	0.015
≥3 times/week	121 (24.7)	0.54 (0.34–0.87)	0.011	0.56 (0.35–0.90)	0.016	
Leafy green vegetables						
Less than weekly	195 (39.9)	1		1		
1–2 times/week	190 (38.8)	0.77 (0.52–1.13)	0.182	0.80 (0.54–1.19)	0.276	0.013
≥3 times/week	104 (21.3)	0.59 (0.36–0.94)	0.026	0.54 (0.33–0.87)	0.011	
Tomatoes						
Less than weekly	251 (51.7)	1		1		
1–2 times/week	109 (22.5)	0.86 (0.55–1.36)	0.521	0.88 (0.56–1.39)	0.578	0.076
≥3 times/week	125 (25.8)	0.69 (0.45–1.04)	0.077	0.68 (0.45–1.04)	0.074	
Carrots						
Less than weekly	328 (67.4)	1		1		
≥1 times/week	159 (32.6)	1.10 (0.76–1.59)	0.607	1.08 (0.74–1.57)	0.685	
Use of fresh herbs (*n*)						
Low (≤ 1)	57 (11.7)	1		1		
Medium (2–3)	195 (39.9)	0.91 (0.51–1.61)	0.738	0.91 (0.51–1.63)	0.746	0.376
High (4)	237 (48.5)	0.75 (0.42–1.31)	0.308	0.80 (0.45–1.42)	0.443	
Fruits						
Up to 4 times/week	154 (31.5)	1		1		
5–7 times/week	149 (30.5)	0.76 (0.49–1.18)	0.226	0.75 (0.48–1.17)	0.199	0.036
More than daily	186 (38.0)	0.60 (0.39–0.91)	0.016	0.63 (0.41–0.97)	0.035	
Citrus fruits						
Never/rarely	216 (44.5)	1		1		
<1 time/week	143 (29.5)	0.76 (0.51–1.15)	0.201	0.73 (0.48–1.12)	0.148	0.660
≥1 time/week	126 (26.0)	0.97 (0.63–1.49)	0.881	0.95 (0.61–1.48)	0.831	
Nuts						
Less than weekly	379 (77.5)	1		1		
≥1 time/week	110 (22.5)	1.03 (0.68–1.56)	0.872	1.13 (0.74–1.73)	0.560	
Exclusive use of olive oil						
No	27 (5.5)	1		1		
Yes	462 (94.5)	0.73 (0.34–1.53)	0.402	0.76 (0.36–1.61)	0.470	

OR, odds ratio; CI, confidence interval.

a: Totals may vary because of missing values.

b: Estimated by ordered logit model.

c: OR adjusted for age and sex.

d: OR adjusted for age, sex, BMI, physical activity and cognitive status.

e: Test for trend (Wald test).

Table 3 Weekly consumption of animal origin foods and categories of comorbidity-polypharmacy score

Characteristics	Study base ($N = 490$) N (%)[a]	OR[b,c] (95% CI)	P	OR[b,d] (95% CI)	P	P_{trend}[e]
Milk						
Less than weekly	117 (23.9)	1		1		
1–7 times/week	197 (40.2)	0.80 (0.51–1.25)	0.324	0.83 (0.53–1.29)	0.404	0.088
More than daily	176 (35.9)	0.63 (0.40–0.99)	0.047	0.67 (0.42–1.07)	0.091	
Butter						
Never	384 (79.7)	1		1		
Rarely or <1 time/week	42 (8.7)	0.61 (0.33–1.13)	0.118	0.58 (0.31–1.07)	0.079	0.430
≥1 time/week	56 (11.6)	0.98 (0.57–1.69)	0.943	0.93 (0.54–1.61)	0.803	
Eggs						
Never/rarely	71 (14.5)	1		1		
<1 time/week	142 (29.0)	1.20 (0.69–2.08)	0.512	1.26 (0.72–2.19)	0.418	0.846
≥1 time/week	277 (56.5)	0.94 (0.57–1.56)	0.816	1.04 (0.63–1.73)	0.871	
Cheese						
<1 time/week	127 (25.9)	1		1		
1–2 times/week	176 (35.9)	1.06 (0.68–1.65)	0.804	1.14 (0.73–1.79)	0.572	0.750
≥3 times/week	187 (38.2)	0.85 (0.55–1.32)	0.460	0.95 (0.61–1.49)	0.822	
Fish						
<1 time/week	140 (28.6)	1		1		
≥1 time/week	350 (71.4)	0.93 (0.63–1.36)	0.702	0.95 (0.65–1.41)	0.816	
Fish rich in n–3 fatty acids **						
<1 time/week	295 (60.3)	1		1		
≥1 times/week	194 (39.7)	1.26 (0.88–1.80)	0.199	1.25 (0.87–1.79)	0.225	
Shellfish						
<1 time/week	433 (88.7)	1		1		
≥1 time/week	55 (11.3)	1.17 (0.67–2.02)	0.582	1.19 (0.68–2.07)	0.546	
Meat						
<1 time/week	76 (15.5)	1		1		
1–2 times/week	218 (44.5)	1.08 (0.64–1.80)	0.776	1.03 (0.61–1.72)	0.924	0.492
≥3 times/week	196 (40.0)	1.19 (0.71–1.99)	0.518	1.16 (0.69–1.96)	0.570	
Liver and offals						
No	316 (64.5)	1		1		
Yes	174 (35.5)	1.26 (0.87–1.81)	0.220	1.19 (0.82–1.72)	0.365	

OR, odds ratio; CI, confidence interval.
a: Totals may vary because of missing values.
b: Estimated by ordered logit model.
c: OR adjusted for age and sex.
d: OR adjusted for age, sex, BMI, physical activity and cognitive status.
e: Test for trend (Wald test).

high intake (≥5 times weekly) of cooked vegetables (OR: 0.55, 95% CI: 0.36–0.85; P-trend = 0.008), high intake (≥3 times weekly) of cruciferous (OR: 0.56, 95% CI: 0.35–0.90; P-trend= 0.015) and high intake (≥3 times weekly) of leafy green vegetables (OR: 0.54, 95% CI: 0.33–0.87, P-trend = 0.013) and high intake (more than daily) of fruits (OR: 0.63, 95% CI: 0.41–0.97; P-trend = 0.036) were all inversely associated with CPS, after controlling for sex, age, BMI, physical activity and cognitive status.

No association was found between the intake of other foods or group of foods of the Mediterranean diet such as fish, fresh herbs, nuts and olive oil and CPS.

Table 3 reports the association between consumption of animal origin foods and the CPS. An inverse association was found between CPS and consumption of milk (≥7 times weekly) (OR: 0.63, 95% CI: 0.40–0.99). However, the ORs for high consumption of milk became non-significant after controlling for confounders (sex, age, BMI, physical activity and cognitive status).

Table 4 shows the association between consumption of beverages and the CPS. Median daily intake of wine was one glass. After controlling for sex, age, BMI, physical activity and cognitive status, high consumption of wine was inversely associated with CPS (OR: 0.51, 95% CI: 0.27–0.96; P-trend = 0.012). A variable was created for exclusive wine consumption and the association was even more evident (OR: 0.30, 95% CI: 0.11–0.79; P-trend = 0.006). Moderate consumption of coffee (3–7 times weekly) (OR: 0.63, 95% CI: 0.40–1.00) was borderline associated with CPS.

In all models, walking regularly outdoors for at least 15 min for 4 times weekly or more remained inversely associated with CPS while older age (≥75 years) and high BMI (≥25) remained positively associated with CPS.

To further confirm the findings, we conducted some sensitivity analysis. In a sensitivity analysis, we excluded subjects ($N = 93$) with a BMI < 22 and a BMI > 33[22] and the effects remained, although with wider CIs (e.g. cruciferous vegetables, OR: 0.57, 95% CI: 0.33–0.97; leafy green vegetables, OR: 0.63; 95% CI: 0.37–1.07). In another sensitivity analysis, we included only subjects in which consumption of wine was less than weekly ($N = 309$) and the protective effect remained (e.g. cruciferous vegetables, OR: 0.48; 95% CI: 0.26–0.86; leafy green vegetables, OR: 0.44; 95% CI: 0.24–0.82).

Discussion

A healthy lifestyle has been shown to have many beneficial effects for the prevention of diabetes and its complications.[7] To the best of our knowledge, there is no study that is investigating if a healthy lifestyle can modulate the intensity of medicines need to treat comorbidities among older people with diabetes.

In this study, we showed that high intake of some food items of the Mediterranean diet and regular walking outdoors are inversely associated with the intensity of medicines need to treat comorbidities, after controlling for all potential factors. High consumption of cooked vegetables, salad, leafy green and cruciferous vegetables was

Table 4 Weekly consumption of beverages and categories of comorbidity-polypharmacy score

Characteristics	Study base ($N = 490$) N (%)[a]	OR[b,c] (95% CI)	P	OR[b,d] (95% CI)	P	P_{trend}[e]
Wine						
Less than weekly	309 (63.7)	1		1		
1–7 times/week	130 (26.8)	0.64 (0.42–0.98)	0.042	0.65 (0.42–1.00)	0.052	0.012
More than daily	46 (9.5)	0.48 (0.26–0.90)	0.022	0.51 (0.27–0.96)	0.036	
Exclusive wine consumption						
Less than weekly	217 (73.8)	1		1		
1–7 times/week	60 (20.4)	0.67 (0.37–1.21)	0.183	0.60 (0.33–1.10)	0.097	0.006
More than daily	17 (5.8)	0.28 (0.11–0.75)	0.011	0.30 (0.11–0.79)	0.014	
Liquorous wine						
Non-drinkers	420 (86.6)	1		1		
Drinkers	65 (13.4)	0.87 (0.52–1.45)	0.595	0.80 (0.48–1.33)	0.385	
Beer						
Never	323 (66.5)	1		1		
Rarely or <1 time/week	141 (29.0)	0.79 (0.53–1.19)	0.261	0.80 (0.54–1.21)	0.297	0.487
≥1 time/week	22 (4.5)	0.86 (0.38–1.95)	0.720	0.99 (0.43–2.25)	0.977	
Spirits						
Non-drinkers	429 (87.9)	1		1		
Drinkers	59 (12.1)	0.73 (0.43–1.26)	0.262	0.75 (0.44–1.29)	0.298	
Tea						
Never	211 (43.6)	1		1		
Up to 2 times/week	194 (40.1)	0.85 (0.58–1.24)	0.392	0.82 (0.56–1.22)	0.330	0.729
≥3 times/week	79 (16.3)	0.95 (0.57–1.57)	0.844	0.99 (0.59–1.65)	0.963	
Coffee						
Up to 2 times/week	108 (22.3)	1		1		
3–7 times/week	238 (49.1)	0.61 (0.39–0.96)	0.034	0.63 (0.40–1.00)	0.049	0.137
≥7 times/week	139 (28.7)	0.60 (0.37–0.98)	0.043	0.66 (0.40–1.09)	0.104	

OR, odds ratio; CI, confidence interval.
a: Totals may vary because of missing values.
b: Estimated by ordered logit model.
c: OR adjusted for age and sex.
d: OR adjusted for age, sex, BMI, physical activity and cognitive status.
e: Test for trend (Wald test).

associated with a lower risk of intensity of medicines need to treat comorbidities.

The results of our study are partially in agreement with another study that showed beneficial effects of the Mediterranean diet, on polypharmacy among 476 subjects aged 50–89 years old with cardiometabolic disorders including diabetes.[23] However, the authors did not take into account of the intake of different types of vegetables and they also did not control for physical activity in the models.

One possible biological mechanism to explain the protective effect of vegetables, in particular, high intake of cruciferous vegetables and salad on the intensity of medicines need to treat comorbidities may be through the prevention of complications linked to diabetes. At experimental level sulphoraphane has been shown to prevent vascular complication in diabetes via its antioxidative properties and by also inhibition the glycation end products (AGEs) and suppression of the AGE-induced inflammatory reactions in rat aorta.[24] In a small clinical study of 4 weeks, broccoli sprouts powder (BSP), that contained high concentration of sulphoraphane consumption of 10 g/day BSP resulted in a significant decrease in serum insulin concentration.[25] Salad, leafy green vegetables, wine and fruits are all rich in polyphenols that have antioxidant and anti-inflammatory properties and may regulate glucose homeostasis and insulin sensitivity.[24,26] Leafy green vegetables are also rich in folic acid. Folic acid absorption has been shown to decrease by the prolonged use of metformin in patients with diabetes leading to increase levels of homocysteine (Hcy) and thus oxidative stress.[27] The protective effect of wine observed in our study could be due to reverse causality. However, no other alcoholic beverages in this study were associated with a protective effect for CPS except wine that is known to be rich in polyphenols that act as antioxidant, anti-inflammatory and may regulate glucose homeostasis and insulin sensitivity.[24,26] Another possible explanation for the protective effect of wine consumption is that in Italy, traditionally, wine is consumed during meals which decreases alcohol absorption[28] remaining only the beneficial effect of polyphenols.

In this study, regular walking outdoors for at least 15 min was also found inversely related to the intensity of medicines need to treat comorbidities. Physical exercise has been shown to increase high-density lipoprotein (HDL). HDL besides its role in cholesterol removal, it is also an antioxidant, it inhibits inflammation and thrombosis and might also influence glucose homeostasis through mechanisms including insulin secretion, enhanced insulin sensitivity and direct glucose uptake by muscle.[29] In a 6 years cohort study conducted among Japanese with diabetes, physical activity was associated with a protective effect for cardiovascular events.[30]

The strengths of the study are its methodology of collecting individual detailed data, by means of face-to-face interviews and direct body measures; the high participation rate; the employment of the CPS index, allowing us to more accurately characterize the 'frailty' or the 'physiological age' of our patients—compared to traditional methods considering comorbidities and polypharmacy independently—by taking into account for the synergistic effect of the presence of multiple diseases and multiple medical treatments, a frequent condition observed especially among elderly patients[17]; the use of the logit model with a three-level variable as the outcome allowed us to investigate the association between lifestyle factors and intensity of polypharmacy need to treat comorbidities, controlling for several confounding factors.

This study has the typical limitation of the cross-sectional studies that no inference about a causal relation between exposure and outcome can be assured. However, a dose–response relationship between dietary variables and CPS was observed. Another limitation of the study is that the results were based in a single centre. Nonetheless, San-Camillo is a reference centre for diabetes in the Lazio Region. Moreover, despite the availability of a large amount of information at individual base, we cannot exclude the possibility of potential residual or unmeasured confounding.

Conclusions

Finally, our findings suggest that older people with type II diabetes that regularly walk outdoors and eat a diet characterized by a high consumption of some typical food items of the Mediterranean diet such as green leafy, cruciferous vegetables and fruits have a decreased risk of polypharmacy to treat comorbidities. Following the latter healthy lifestyle profile probably minimizes long-term complications and consequently the number of medications used by older adults with type II diabetes. However, further studies should be conducted to confirm the findings.

Supplementary data

Supplementary data are available at *EURPUB* online.

Acknowledgements

The authors acknowledge Kasturi Sen for comments and suggestions.

Funding

This work was supported by the Lazio Regium within the independent drug research programme 'Regional funds for the Pharmacovigilance' and by the Istituto Dermopatico dell'Immacolata, IDI-IRCCS.

Conflicts of interest: None declared.

Key points

- Comorbidity-polypharmacy score was employed to characterize frailty in elderly patients.
- Elderly with diabetes following Mediterranean diet and/or regularly walking outdoor have lower polypharmacy-comorbidity score.
- Following a healthy lifestyle decreases the number of medications used by older people with type II diabetes.

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