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Dietary patterns and risk of self-reported activity limitation in older adults from the Three-City Bordeaux Study

Sophie Pilleron[1]*, Karine Pérès[1], Marthe-Aline Jutand[1,2], Catherine Helmer[1], Jean-François Dartigues[1], Cécilia Samieri[1] and Catherine Féart[1]

[1]*Université Bordeaux, Inserm, Bordeaux Population Health Research Center, UMR 1219, F-33000 Bordeaux, France*
[2]*Bordeaux University EA 7440-CeDS 'Cultures et Diffusion des Savoirs', F-33000 Bordeaux, France*

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Abstract

Few studies have been interested in the relationship between dietary patterns and activity limitation in older adults yet. We analysed the association between dietary patterns and the risk of self-reported activity limitation – that is mobility restriction, limitation in instrumental activities in daily living (IADL) and in activities in daily living (ADL) – in community-dwellers aged 67+ years initially free of activity limitation in 2001–2002 and re-examined at least once over 10 years – that is 583 participants for mobility restriction, 1114 for IADL limitation and 1267 for ADL limitation. At baseline, five sex-specific dietary clusters were derived by hybrid clustering method from weekly frequency of intake of twenty food and beverage items. Self-reported mobility restriction, limitations in IADL and in ADL were assessed using the Rosow–Breslau, the Lawton–Brody and the Katz scales, respectively. Associations between dietary clusters and the risk of each activity limitation were assessed using Cox proportional hazard models. In models adjusted for socio-demographic and health-related covariates, compared with the 'Healthy' cluster the 'Biscuits and snacking' cluster was associated with a higher risk of mobility restriction (hazard ratio (HR) = 3·0; 95 % CI 1·6, 5·8) and limitation in IADL (HR = 2·1; 95 % CI 1·1, 4·2) in men and limitation in ADL in women (HR = 2·3; 95 % CI 1·3, 4·0). In this French cohort of community-dwellers aged 67+ years, some unhealthy dietary patterns may increase the risk of activity limitation all along the disablement process in older adults.

Key words: **Older adults: Dietary patterns: Activity limitation: Cohort studies: Prospective studies**

Low probability of activity limitation is one criterion for successful ageing[1]. Activity limitation results from a long-standing process, known as the 'disablement process'[2]. Nutrition may influence this dynamic process[3]. Higher intake of some individual foods, particularly vegetables, fruit, dairy products and some micronutrients, were associated with a reduced risk of activity limitation[4–8]. However, as nutrients may interact with others, studying them in combination in dietary patterns has been encouraged when analysing the role of diet in the disablement process[3]. Higher adherence to a Mediterranean diet – that is predefined healthy dietary pattern – was associated with a slower decline of mobility and a lower risk of developing new mobility limitation over 9 years[9], and a lower risk of limitation in activities of daily living in older women over 5 years[10]. A healthy diet assessed by the Healthy Eating Index score was also associated with a reduced risk of activity limitation[11,12]. Thus far, only one Japanese study analysed the relationship between *a posteriori* dietary patterns – that is derived independently of any prior hypotheses about their beneficial effect on health – and the 5-year risk of activity limitation in adults aged 73·9 (SD 6·0) years on average[13]. In this study, the Japanese diet, characterised by high intake of fish, vegetables, mushrooms, potatoes, seaweeds, pickles, soyabean and fruit, was associated with a lower risk of incident activity limitation. As *a posteriori* patterns are population- and cultural-specific, extrapolating these data to other settings is difficult. In a previous study, we derived five sex-specific dietary clusters in older French community-dwellers from the Three-City (3C) Bordeaux study[14]. Specific unhealthy clusters were associated with worse cognitive function, and higher depressive symptomatology[14], both being risk factors for activity limitation[15,16]. We also showed that some dietary clusters were associated with incident frailty[17], which is a predictor of disability but is not equivalent to it[18].

We therefore investigated the association between dietary clusters and the 10-year risk of activity limitation in French older adults in the Bordeaux sample of the 3C Study.

Methods

Study population

The study was conducted in the Bordeaux sample of the 3C Study, a prospective cohort study of vascular risk factors for

Abbreviations: ADL, activities in daily living; IADL, instrumental activities in daily living.

* **Corresponding author:** S. Pilleron, email sophie_pilleron@hotmail.com

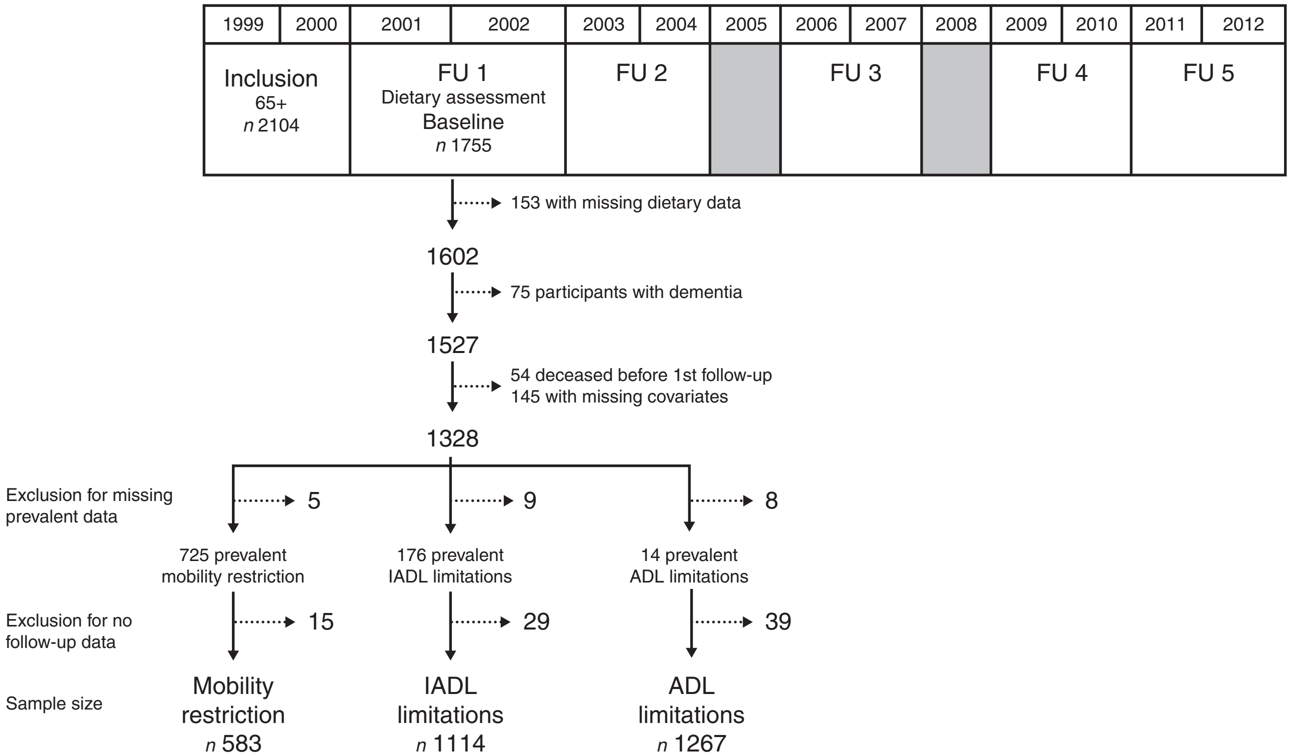

Fig. 1. Flow chart of studied samples, The Three-City Bordeaux Study. FU, follow-up; ADL, activities in daily living; IADL, instrumental activities in daily living.

dementia that included 2104 community-dwellers aged 65 years or older in 1999–2000[19]. The protocol and baseline characteristics have been detailed previously[19]. In brief, all individuals aged 65 years and older living in Bordeaux, France, registered on the electoral rolls and not institutionalised were eligible. The participants' selection was carried out in each administrative district, with individuals sampled randomly proportional to the district's population[19]. At baseline, the standard data collection performed by trained psychologists included socio-demographic and lifestyle characteristics, medical history, neuropsychological testing, a physical examination and blood sampling. Five follow-up examinations were performed 2 years (wave 1, 2001–2002), 4 years (wave 2, 2003–2004), 7 years (wave 3, 2006–2007), 10 years (wave 4, 2009–2010) and 12 years (wave 5, 2011-2012) later.

A 24-h dietary recall and a detailed food frequency questionnaire were administered by trained dietitians at wave 1; this analysis was therefore based on data from wave 1 (hereinafter referred to as baseline) to wave 5.

Fig. 1 portrays the detailed flow chart of analysis samples. Briefly, out of 1755 participants at baseline, we retained 583 (274 men and 309 women) for the analysis of the risk of mobility restriction, 1114 (451 men and 663 women) for the analysis of the risk of instrumental activities in daily living (IADL) and 1267 (491 men and 776 women) for the analysis of the risk of activities in daily living (ADL).

Ethical considerations

This study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects were approved by the Consultative Committee for the Protection of Persons participating in Biomedical Research of the Kremlin-Bicêtre University Hospital (Paris). Written informed consent was obtained from all subjects.

Dietary assessment

A FFQ and a 24-h dietary recall were administered by specifically trained dietitians during the same interview[20]. For the 24-h dietary recall, portions size was assessed using photographs. The number of weekly servings of food obtained from the FFQ had moderate but significant correlations (0·20–0·43), with nutrient intakes obtained from the 24-h dietary recall but for PUFA, vitamin D and Zn[20,21]. Frequency of consumption of 148 food items and non-alcoholic beverages for six meals (three main, three between-meal snacks) obtained from the FFQ was transformed into discrete variables as follows: 0 for never or less than once a week, 0·25 for once a month, 0·5 for twice a month, 0·75 for three times a month, 1 for once a week and from 2 for twice a week to 7 for seven times a week. This coding was used to estimate the number of usual weekly servings of each of 148 food items recorded, ranging as a result from 0 to 49. The number of glasses of alcohol per week was also recorded. The 148 food items were then aggregated into twenty food and beverage groups (see the online Supplementary Fig. S1)[14].

Dietary clusters

On the basis of the twenty food and beverage groups, we previously characterised five sex-specific dietary clusters by hybrid

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clustering method in 647 men and 1077 women[14] (see the online Supplementary Fig. S1 for a summary of clusters identified on the 3C Bordeaux sample). In brief, the cluster analysis was based on the average number of weekly servings and performed using a mixed method combining hybrid clustering and research of stable groups during the k-means step[14]. As a result, among men and women, the most frequent cluster, labelled 'small eaters', was characterised by a lower intake of all food groups and a lower daily energy intake. The second most frequent cluster, labelled 'healthy', was characterised by a higher fish intake in men and a higher fruit and vegetable intake in women. In both sexes, the cluster labelled 'Biscuits and snacking' grouped together individuals having frequent snacks, a frequent intake of biscuits and cakes and a slightly higher energy intake. The fourth cluster was a 'charcuterie, meat and alcohol' cluster in men and a 'charcuterie, starchy food and alcohol' cluster in women. A fifth cluster included frequent 'pasta' eaters in men and 'pizza, sandwich' eaters in women.

Activity limitation

At each follow-up of the 3C study participants, mobility and limitation in IADL or ADL were investigated. Three self-reported items from the Rosow–Breslau scale were used to assess mobility: 'doing heavy housework', 'walking half a mile' and 'climbing stairs'[22]. Activity limitation in IADL was assessed using the Lawton–Brody scale that assesses the self-reported ability of the participants to use a telephone, manage medication, manage money, use public or private transport and do shopping, for both sexes, and additionally to do the laundry, do housework and prepare meals for women[23]. Limitation in ADL was assessed using five self-reported items of the Katz scale[24]: bathing, dressing, toileting, transferring from bed to chair and eating. Incontinence was not considered here because it is an impairment rather than an activity limitation[25]. For each domain, a participant was considered disabled if he or she reported not to be able to perform at least one activity without a given level of assistance[22–24].

Other data

At baseline, socio-demographic information included age, sex, education (no or primary school, secondary school, high school and university), monthly income (<1500 €, 1500–2250 € and ≥2250 €) and marital status (married and divorced/separated/widowed/single). Smoking status assessed in 1999–2000 was categorised into non-smoker, ex-smoker and current smoker. BMI was computed as the weight/height squared ratio and expressed in kg/m². As fifteen out of 1328 participants had BMI $< 18{\cdot}5\,kg/m^2$, BMI was categorised into sex-specific tertiles. Multimorbidity was defined as ≥2 self-reported chronic diseases among cancer, hypertension, diabetes, hypercholesterolaemia, angina, cardiac rhythm disorders, cardiac failure, arteritis, myocardial infarction, asthma, Parkinson's disease, dyspnoea, osteoporosis and thyroid diseases. Global cognitive performance was assessed using the Mini-Mental State Examination (MMSE)[26] and depressive symptomatology using the Center for Epidemiological Studies-Depression scale (CES-D)[27,28]. Participants underwent an extensive neurological testing for dementia, and an independent committee of neurologists made dementia diagnoses using DSM-IV criteria. Total energy intake per day was estimated from the 24-h dietary recall.

Statistical analyses

All analyses were performed separately in men and women as dietary clusters were sex specific.

We described dietary clusters based on baseline characteristics using appropriate statistics and statistical tests.

The associations between dietary clusters and the risks of mobility restriction and limitation in IADL or ADL were assessed using separated Cox proportional hazard models with age as the underlying time scale and delayed entry. The age at restriction/activity limitation onset was considered to be the age at midpoint of the interval between the diagnosis visit and the previous one as our data were interval-censored. Participants never considered as restricted/limited during the follow-up were censored at their last visit. We hypothesised that the 'Healthy' cluster is associated with the lowest risk of restriction/activity limitation; therefore, this cluster was chosen as the reference category. All models were adjusted for marital status, education level, income, smoking status, multimorbidity, BMI, depressive symptomatology and MMSE.

In a sensitivity analysis, we re-ran all models adjusted further for total energy intake (online Supplementary Table S1).

Statistical analyses were performed with SAS Statistical package release 9·3 (SAS Institute Inc.) and the R package 'Survival'.

Results

Sample characteristics

Participants were aged 75·7 years on average at baseline, and they were followed up during 9·0 years on average. The 10-year incidence of mobility restriction, limitation in IADL and limitation in ADL was 12·0, 5·0 and 1·2 %, respectively, in men and 18·0, 6·7 and 1·9 %, respectively, in women.

Descriptive characteristics according to dietary clusters are displayed in Table 1 for men and Table 2 for women. Among men, 30·6 % were classified in the 'Small eaters' cluster, 7·7 % in the 'Biscuits and snacking' cluster, 25·8 % in the 'Healthy' cluster, 14·6 % in the 'Charcuterie, meat and alcohol' cluster and 21·2 % in the 'Pasta' cluster (Table 1). Men in the 'Healthy' cluster are less depressed but more likely to report multimorbidity than men in the other clusters.

Among women, 30·3 % were in the 'Small eaters' cluster, 13·5 % in the 'Biscuits and snacking' cluster, 27·3 % in the 'Healthy' cluster, 24·7 % in the 'Charcuterie, starchy foods' cluster and 4·2 % in the 'Pizza, sandwich' cluster (Table 2).

Dietary clusters and incident activity limitation

Compared with the 'Healthy' cluster, men in the 'Biscuits and snacking' cluster were significantly at higher risk of mobility restriction (hazard ratio (HR) = 3·0; 95 % CI 1·6, 5·8 adjusted for marital status, education level, income, smoking status, multimorbidity, BMI, CES-D and MMSE scores; $P_{\text{for global test}} = 0{\cdot}01$,

Table 1. Baseline socio-demographic and health characteristics of elderly men based on dietary clusters, the Bordeaux sample of the Three-City study, 2001–2002 (*n* 519)*
(Numbers and percentages; mean values and standard deviations)

	Overall		Dietary clusters: Small eaters		Biscuits and snacking		Healthy		Charcuterie, meat, alcohol		Pasta		
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*P*
Sample	519		159	30·6	40	7·7	134	25·8	76	14·6	110	21·2	
Socio-demography													
Age (years)													0·48
Mean	75·4		75·2		76·2		75·9		75·1		75·1		
SD	4·6		4·4		4·8		4·6		4·7		4·7		
Marital status													0·07
Married	408	78·6	123	77·4	30	75·0	109	81·3	52	68·4	94	85·5	
Single, divorced, separated, widower	111	21·4	36	22·6	10	25·0	25	18·7	24	31·6	16	14·6	
Education level													0·50
No or primary school	134	25·8	46	28·9	8	20·0	31	23·1	23	30·3	26	23·6	
Secondary	137	26·4	46	28·9	10	25·0	34	25·4	19	25·0	28	25·5	
High school	110	21·2	30	18·9	13	32·5	25	18·7	19	25·0	23	20·9	
University	138	26·6	37	23·2	9	22·5	44	32·8	15	19·7	33	30·0	
Income, euros													0·26
<1500	111	21·4	34	21·4	6	15·0	21	15·7	22	29·0	28	25·5	
1500–2250	165	31·8	51	32·1	14	35·0	41	30·6	27	35·5	32	29·1	
≥2250	241	46·8	74	46·5	20	50·0	72	53·7	27	35·5	50	45·5	
Health													
Smoking status													$2 \cdot 10^{-2}$
Never	160	30·8	46	29·0	12	30·0	41	30·6	20	26·3	41	37·3	
Ex-smoker	315	60·7	101	63·5	26	65·0	86	64·2	41	54·0	61	55·5	
Current smoker	44	8·5	12	7·6	2	5·0	7	5·2	15	19·7	8	7·3	
BMI (kg/m^2)													0·36
Mean	27·0		27·4		26·4		26·8		26·8		27·2		
SD	3·6		3·4		4·3		3·2		2·8		4·4		
MMSE													0·13
Mean	27·8		27·5		27·7		28·0		27·5		27·9		
SD	1·8		2·0		1·7		1·6		1·8		1·7		
CES-D													$3 \cdot 10^{-2}$
Mean	5·5		5·1		5·2		4·7		6·0		6·9		
SD	5·8		6·4		4·5		4·3		5·9		6·5		
Multimorbidity	275	53·0	83	52·2	15	37·5	79	59·0	33	43·4	65	59·1	$4 \cdot 10^{-2}$
Total energy intake (kJ)	*n* 514		*n* 156		*n* 39		*n* 134		*n* 75		*n* 110		<0·001
	481·5	125·5	443·4	115·9	523·0	151·3	488·1	125·3	517·9	127·1	488·1	114·8	

MMSE, Mini-mental state examination; CES-D, Center for Epidemiological Studies-Depression scale.
* Multimorbidity ≥2 chronic diseases among cancer, hypertension, diabetes, hypercholesterolaemia, angina, cardiac rhythm disorders, cardiac failure, arteritis, myocardial infarction, asthma, Parkinson's disease, dyspnoea, osteoporosis and thyroid diseases.

Table 3). Men in the 'Biscuits and snacking' cluster and those in the 'Pasta' cluster were at higher risk of limitation in IADL (HR = 2·1; 95 % CI 1·1, 4·2 and HR = 1·7; 95 % CI 1·0, 2·9, respectively), whereas the global test did not reach statistical significance (P = 0·12). Overall, dietary clusters were not associated with the risk of limitation in ADL among men (P = 0·46).

Among women, dietary clusters were not associated with the risk of mobility restriction and limitation in IADL. However, women in the 'Biscuits and snacking' cluster were significantly at higher risk of limitation in ADL than women belonging to the 'Healthy' cluster (HR = 2·3; 95 % CI 1·3, 4·1; $P_{\text{for global test}}$ = 0·03). The adjustment for total energy intake did not change the associations observed (online Supplementary Table S1).

Discussion

This prospective study in French older community-dwellers showed that, compared with participants belonging to the 'Healthy' cluster, participants in the 'Biscuits and snacking' cluster were at higher risk of mobility restriction and limitation in IADL in men and limitation in ADL in women over 10 years of follow-up. Moreover, men in the 'Pasta' cluster were at higher risk of limitation in IADL over the same period.

To our knowledge, only one study investigated the relationship between *a posteriori* dietary patterns and the risk of activity limitation[13]. This 5-year study conducted in 14 260 Japanese community-dwellers aged 65 years or older identified three dietary patterns using a factor analysis: (i) the Japanese pattern characterised by high intake of fish, vegetables, mushrooms, potatoes, seaweeds, pickles, soyabeans and fruit; (ii) the animal food pattern characterised by a high intake of animal-derived food; and (iii) the high dairy pattern characterised by high consumption of dairy products, margarine and black tea. The healthier pattern,that is the Japanese one, was associated with a decreased risk of activity limitation, whereas the two other patterns were not so. Given that dietary patterns derived from no prior hypothesis are specific to population, the comparison

Table 2. Baseline socio-demographic and health characteristics of elderly women based on dietary clusters, the Bordeaux sample of the Three-City study, 2001–2002 (*n* 809)*
(Numbers and percentages; mean values and standard deviations)

	Overall		Dietary clusters: Small eaters		Biscuits and snacking		Healthy		Charcuterie, starchy foods		Pizza, sandwich		
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*P*
Sample	809		245	30·3	109	13·5	221	27·3	200	24·7	34	4·2	
Socio-demography													
Age (years)													0·14
Mean	75·9		75·9		76·4		76·3		75·2		76·4		
SD	4·8		4·7		5·1		4·8		4·5		5·3		
Marital status													5.10^{-3}
Married	331	40·9	84	34·3	42	38·5	87	39·4	104	52·0	14	41·2	
Single, divorced, separated, widower	478	59·1	161	65·7	67	61·5	134	60·6	96	48·0	20	58·8	
Education level													0·16
No or primary school	301	37·2	103	42·0	45	41·3	72	32·6	65	32·5	16	47·1	
Secondary school	220	27·2	65	26·5	30	27·5	69	31·2	49	24·5	7	20·6	
High school	176	21·8	50	20·4	24	22·0	49	22·2	48	24·0	5	14·7	
University	112	13·8	27	11·0	10	9·2	31	14·0	38	19·0	6	17·7	
Income, euros													5.10^{-3}
<1500	405	50·1	142	58·0	63	57·8	106	48·0	78	39·0	16	47·1	
1500–2250	197	24·4	55	22·5	18	16·5	58	26·2	59	29·5	7	20·6	
≥2250	207	25·6	48	19·6	28	25·7	57	25·8	63	31·5	11	32·4	
Health													
Smoking status													1.10^{-3}
Never	674	83·3	185	75·5	101	92·7	191	86·4	169	84·5	28	82·4	
Ex-smoker	108	13·4	49	20·0	4	3·7	26	11·8	26	13·0	3	8·8	
Current smoker	27	3·3	11	4·5	4	3·7	4	1·8	5	2·5	3	8·8	
BMI (kg/m^2)													2.10^{-2}
Mean	26·2		26·6		26·1		26·7		25·5		25·4		
SD	4·4		4·8		4·1		4·9		3·6		3·4		
MMSE													0·38
Mean	27·6		27·4		27·5		27·7		27·7		27·2		
SD	2·0		2·1		2·0		2·1		1·8		2·1		
CES-D													0·06
Mean	8·9		8·8		10·5		8·6		8·2		11·0		
SD	8·0		7·9		7·9		8·3		7·2		10·2		
Multimorbidity	454	56·1	138	56·3	53	48·6	135	61·1	107	53·5	21	61·7	0·22
Total energy intake (kJ)	*n* 806		*n* 244		*n* 109		*n* 220		*n* 199		*n* 34		<0·001
	363·8	110·3	328·8	108·6	376·4	100·2	359·7	108·8	400·6	105·5	385·6	116·0	

MMSE, Mini-mental state examination; CES-D, Center for Epidemiological Studies-Depression scale.
* Multimorbidity ≥2 chronic diseases among cancer, hypertension, diabetes, hypercholesterolaemia, angina, cardiac rhythm disorders, cardiac failure, arteritis, myocardial infarction, asthma, Parkinson's disease, dyspnoea, osteoporosis and thyroid diseases.

of Japanese study's results with our findings is difficult, especially because the cultural difference between samples is major.

The associations observed in our study are in congruence with our previous works[14,17]. Compared with women in the 'healthy' cluster, women in the 'Biscuits and snacking' cluster were more likely to report poor perceived health[14] and were at higher risk of frailty over 10 years of follow-up[17], whereas men in the 'Biscuits and snacking' cluster or the 'Pasta' cluster were at higher risk of muscle weakness compared with their counterparts in the 'Healthy' cluster[17]. Together, these data suggest that nutritional habits may interfere on the whole disablement process, from mild disorders (i.e. IADL) to severe disability (i.e. ADL).

Compared with participants in the 'Healthy' cluster, those in the 'Biscuits and snacking' cluster were characterised by higher intakes of monosaccharides and disaccharides, and low intake of fruit, vegetables and fish. Simple carbohydrates were positively correlated with inflammatory biomarkers[29]. Significant associations between inflammation and activity limitation were observed in several epidemiological studies[30,31]. Fruit and vegetables are rich in anti-inflammatory (i.e. carotenoids) and antioxidant nutrients (i.e. vitamin C, flavonoids, polyphenols, etc.). Fruit and vegetable intake was inversely correlated with activity limitation[5]. In a 6-year study, higher total plasma carotenoids were significantly associated with a less steep decline in 4-m walking speed and a lower risk of developing severe walking activity limitation[32]. Low plasma carotenoid levels were associated with poor muscle strength and performance, and sarcopaenia[33–36]. High oxidative stress level was an independent predictor of decline in walking speed and progression to severe walking limitation among older women followed up over 3 years[37].

Beyond probable deficiencies in micronutrients and too high intake of refined sugar, 'Biscuits and snacking' cluster is also characterised by destructuring of meals; this cluster may thus represent a vulnerable group regarding nutritional status but also be a marker of deterioration of the health status[14].

Men in the 'Pasta' cluster had a higher risk for limitation in IADL. This finding is consistent with our previous ones. Men in

Table 3. Multivariate associations* between dietary clusters and incident functional limitations and disabilities, Three-City Study, Bordeaux, France (Hazard ratios (HR) and 95 % confidence intervals)

	Mobility				IADL				ADL			
	No cases	HR	95 % CI	*P*	No cases	HR	95 % CI	*P*	No cases	HR	95 % CI	*P*
Men		*n* 274				*n* 451				*n* 491		
Dietary cluster	182			$1 \cdot 10^{-2}$	153			0·12	44			0·46
Healthy	53	1†‡	–		38	1§	–		9	1†	–	
Small eaters	53	1·02	0·68, 1·54		47	1·54	0·96, 2·46		20	2·03	0·79, 5·26	
Biscuits and snacking	15	3·01	1·57, 5·76		13	2·14	1·10, 4·16		1	0·64	0·07, 5·53	
Charcuterie, meat, alcohol	24	0·79	0·47, 1·33		22	1·34	0·75, 2·37		4	1·08	0·29, 3·95	
Pasta	37	1·21	0·76, 1·92		33	1·72	1·04, 2·87		10	1·36	0·46, 3·99	
Women		*n* 309				*n* 663				*n* 776		
Dietary cluster	262			0·98	310			0·91	117			$3 \cdot 10^{-2}$
Healthy	75	1	–		90	1	–		28	1	–	
Small eaters	74	1·03	0·74, 1·44		96	1·07	0·80, 1·45		41	1·41	0·85, 2·35	
Biscuits and snacking	26	1·03	0·65, 1·63		34	1·03	0·69, 1·54		25	2·30	1·31, 4·01	
Charcuterie, starchy foods	74	1·03	0·73, 1·45		74	1·17	0·85, 1·62		19	1·03	0·57, 1·89	
Pizza, sandwich	13	1·24	0·67, 2·30		16	1·02	0·59, 1·75		4	0·86	0·30, 2·52	

ADL, activities in daily living; *n*, analytic sample size; IADL, instrumental activities in daily living.
* Adjusted for marital status, education level, income, smoking status, multimorbidity, BMI, Center for Epidemiological Studies-Depression scale and Mini-Mental State Examination.
† Stratified on education.
‡ Stratified on smoking status.
§ Smoking status was dichotomised into never smoker *v.* ex-smoker and current smoker.

the 'Pasta' cluster had poorer self-rated health and higher depressive symptoms[14] that were both risk factors for activity limitation[16,38,39]. The 'Pasta' cluster was also associated with higher risk of frailty and muscle weakness[17]. However, no mechanistic hypothesis can be formulated to explain these associations. A potential reverse causality bias may persist, although we excluded prevalent cases of activity limitation.

It was noteworthy that our results underlined a sex-specific association between dietary clusters and the risk for activity limitation. In the disablement process, functional limitation precedes activity limitation and activity limitation in IADL precedes activity limitation in ADL[2,40]. In our study, dietary clusters were associated with early stages in men (i.e. mobility restriction, limitation in IADL), whereas they were associated with the latest stage of the disablement process in women (i.e. limitation in ADL). It is widely accepted that older women suffer from higher rates of activity limitation compared with men, and some studies suggested that this fact is almost universal[41]. Indeed, women have a longer life expectancy than men; therefore, women are at a higher risk of experiencing activity limitation periods than men. The latter may die at a younger age without having experienced limitation in ADL. We cannot therefore exclude that the sex-specific association between dietary clusters and the risk of activity limitation may be due to a survival effect. In addition, the analytic sample size of men was small, which may lead to a lack of statistical power.

Our study has some limitations. Dietary clusters were built based on intake frequencies of major food groups that may not accurately reflect portions' size and may be subject to a desirability bias. However, a previous study showed that acceptable correlations were found between number of weekly servings of foods obtained from the FFQ and the corresponding fatty acid intakes obtained from the 24-h recall[20]. Another study on an independent subsample (*n* 105) of the Three-City Study showed also significant correlations ranging from 0·20 to 0·43 between number of weekly servings of foods obtained from the FFQ and the corresponding nutrient intakes obtained from the 24-h recall[21]. Strong correlations between the two enquiries were observed for alcohol (*r* 0·73). However, we cannot exclude an overestimation of the validity, as participants were interviewed using the two dietary tools on the same day. Participants may have modified their dietary habits throughout the study. However, we have found a good stability in intake of fruit, vegetables, fish and meat over a 10-year period[42]. Information about mobility restriction, IADL and ADL was self-reported as recommended by the authors of the original scales[22–24]. Direct observation would have probably been more accurate, but this method is very time-consuming and expensive and difficult to implement in a population-based research. However, using the self-reported tools, we could capture the participants' feeling about their ability to do an activity that it is essential and denotes her/his engagement in the activity. Furthermore, we cannot exclude an underestimation of the incidence of activity limitation owing to a potential competing risk with mortality. Nevertheless, dietary clusters were not associated with high mortality risk in our studied sample (data not shown). Last, adjustment for potential confounding factors does not preclude for residual confounding.

The main study strengths are the 10 years of follow-up; the community-dwelling population-based design; the innovative approach with a mixed clustering strategy to identify dietary clusters; and comprehensive adjustment for several confounders.

Conclusion

In this prospective study in French older community-dwellers, some sex-specific dietary patterns seem to be deleterious for activity limitation in the long term. Improving and maintaining healthy dietary habits in older adults may be beneficial for maintaining autonomy and delaying the onset of activity limitation and thus increasing activity limitation-free life expectancy.

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The authors' contributions are as follows: S. P. formulated the question, conducted the data analysis and wrote the first draft; C. F. was involved in the data analysis and interpretation of the data. All authors reviewed the manuscript, provided further contributions and suggestions and approved the final draft.

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Supplementary material

For supplementary material/s referred to in this article, please visit https://doi.org/10.1017/S0007114518001654

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