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Reducing the chronic disease burden in China: tailoring a self-management intervention among Chinese people with chronic lung disease

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Citation
Song, X. (2023, June 6). *Reducing the chronic disease burden in China: tailoring a self-management intervention among Chinese people with chronic lung disease*. Retrieved from https://hdl.handle.net/1887/3620049

Version:	Publisher's Version
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Downloaded from:	https://hdl.handle.net/1887/3620049

Note: To cite this publication please use the final published version (if applicable).

Chapter 2

Associations between obesity and multidimensional frailty in older Chinese people with hypertension

Song XY, Zhang WH, Hallensleben C, Versluis A, van der Kleij R, Jiang ZL, Chavannes NH, and Gobbens R JJ, "Associations between obesity and multidimensional frailty in older Chinese people with hypertension," Clinical Intervention in Aging, vol. 15, pp. 811-820, 2020.
doi: 10.2147/CIA.S234815.

Abstract:

Background

There is a high prevalence of hypertension. Frailty and obesity were the risk factors for hypertension.

Objectives

To investigate the prevalence of multidimensional frailty in older people with hypertension and to examine a possible relationship of general obesity and abdominal obesity to frailty in older people with hypertension.

Methods

A sample of 995 community-dwelling older people with hypertension, aged 65 years and older and living in Zhengzhou (China), completed the Tilburg Frailty Indicator (TFI), a validated self-report questionnaire for assessing multidimensional frailty. In addition, socio-demographic and lifestyle characteristics were assessed by self-report, and obesity was determined by measuring waist circumference and calculating the body mass index.

Results

The prevalence of multidimensional frailty in this older population with hypertension was 46.5%. Using multiple linear regression analysis, body mass index was significantly associated with physical frailty ($p = .001$), and waist circumference was significantly positively associated with multidimensional frailty and all three frailty domains. Older age was positively associated with multidimensional frailty, physical frailty, and psychological frailty, while gender (woman) was positively associated with multidimensional, psychological, and social frailty. Furthermore, comorbid diseases and being without a partner were positively associated with multidimensional, physical, psychological, and social frailty. Of the lifestyle characteristics, drinking alcohol was positively associated with frailty domains.

Conclusions

Multidimensional frailty was highly prevalent among Chinese community-dwelling older people with hypertension. Abdominal obesity could be a concern in physical frailty, psychological frailty, and social frailty, while general obesity was concerning about physical frailty.

Introduction

Evidence suggests that frailty becomes more prevalent with increasing age and decreasing well-being in the older population [99,100]. Frail older people show declines in physiological reserves and function across multiorgan systems, leading to increased morbidity and mortality [101]. Currently, there is no unified definition of frailty [102-104], as some researchers define frailty based on biomedical indicators [102,103], while others define frailty more broadly [104,105]. In the broader definition of frailty, besides physical frailty, aspects of both the psychological and social domains are included in frailty and collectively this model is referred to as 'multidimensional frailty'[106].

In this study, we adopted the definition of multidimensional frailty outlined by Gobbens et al: "Frailty is a dynamic state affecting an individual who experiences losses in one or more domains of human functioning (physical, psychological, social), which is caused by the influence of a range of variables and which increases the risk of adverse outcomes" [104]. Chronic disease is an important determinant of multidimensional frailty, and hypertension is one of the most common chronic diseases among those aged 65 years and older. Hypertension is not only the main risk factor for cardiovascular diseases, but is also associated with multidimensional frailty [107-109]. Multidimensional frailty is closely associated with a risk of falling and a lower quality of life [110,111]. Greater awareness of the relationship between hypertension and frailty may help reduce adverse outcomes and decrease the prevalence of frailty [102,103].

There has been a steady increase in the prevalence of obesity in older populations, and its negative impact on everyday life increases significantly with age [112,113]. The prevalence of obesity in older populations is a growing concern, because as fat mass increases and muscle mass decreases, in addition to age-related declines in basal metabolic rate, muscle strength and physical activity [114]. Obesity is also associated with other diseases, including diabetes mellitus, hypertension, coronary artery disease, and chronic heart failure [115]. Commonly used measures of obesity include body mass index (BMI) and waist circumference (WC). The former is more closely related to general obesity and body weight, while the latter may more accurately reflect abdominal obesity and is more closely associated with metabolic disorders. There is evidence that obesity, especially in older people, increases the risk of physical inactivity and poor functional performance [116,117]. Several earlier studies examined a possible association between obesity and physical frailty [118-120]. Crow et al. reported that in older adults, frailty was associated with a greater likelihood of high WC (both in dichotomized and continuous measurements) [118]. In addition, obesity is associated with the risk of frailty and frailty syndrome in older women [119,120]. In other studies, obesity was found to be a predictive factor for physical frailty [121,122].

However, studies on a possible link between obesity, fat distribution, and multidimensional

frailty are scarce, and few studies have focused on the relationship between obesity and multidimensional frailty in older people with hypertension.

Obesity has also been associated with psychological problems, e.g., depression and anxiety, although the direction of the association has not yet been established [123,124]. Moreover, obesity, and especially abdominal obesity, has a measurable impact on physical and mental health, health-related quality of life, and generates considerable direct and indirect costs [125]. Therefore, it is reasonable to hypothesize that obesity and multidimensional frailty may be linked.

In this study, our aims were (1) to investigate the prevalence of multidimensional frailty in community-dwelling older people with hypertension, and (2) to explore the relationship of general and abdominal obesity to multidimensional frailty in this specific population.

Methods

Subjects

Between May 2016 and May 2017, a cross-sectional survey was performed in the community of Zhengzhou (China), which included community-dwelling older people ≥65 years old diagnosed with hypertension by a physician (physician diagnosis reported by the participants). Hypertension is defined by a systolic pressure of ≥ 140 or diastolic pressure of ≥ 90. Individuals were excluded if they had an active malignancy, dementia or psychiatric disorders. A random multi-stage cluster sampling method was used to select participants aged 65 and older from the Hangdong, Nanguan, and Qinling communities. In the first stage, the three communities (Hangdong, Nanguan and Qinling) in Zhengzhou were selected, including one in the east, one in the south, and one in the center of the city. The second stage involved the systematic random sampling of community centers from the three chosen communities, 20 in total. During the third stage, a list of residents by age and number of hypertension cases was compiled for each selected site (provided by the local residential committee), and a total of 1200 older people with hypertension were selected, of whom 995 completed the questionnaire. The response rate was 83%.

Ethics

This study was approved by the Institutional Review Board of Zhengzhou University. All information was collected after written consent was obtained from all participants.

Frailty

Frailty was assessed by the Tilburg Frailty Indicator (TFI), a self-report questionnaire [104]. The TFI is divided into three domains: a physical domain, a psychological domain, and a social domain. Physical frailty includes eight components: physical health, unexplained weight loss, difficulty in walking, lack of strength in hands, physical tiredness, difficulty in maintaining balance, poor hearing and poor vision. Psychological frailty consists of four components: cognition, depressive symptoms, anxiety, and

coping. Social frailty includes three components: living alone, lack of social relations, and lack of social support. Eleven items in the TFI have two response categories ("yes" or "no"), while the remaining items (cognition, depressive symptoms, anxiety, lack of social relations) have three response categories ("yes", "no", or "sometimes"); these items were dichotomized. For a detailed description on scoring the TFI, including the dichotomization, we refer to a previous study [106]. Each item was scored with 0 or 1, with a maximum score for overall frailty of 15. For the physical, psychological, and social frailty domains, the maximum scores were 8, 4, and 3, respectively. Total scores greater than or equal to 5 indicate frailty. The physical frailty cutoff is 3, which means people who score 3 in that domain are physically frail [106]. We used the Chinese version of the TFI, which was recently validated in community-dwelling older people [126]. In the present study, the internal consistency and reliability of the Chinese version was acceptable (Cronbach's α=0.747).

Lifestyle characteristics, Body Mass Index and Waist Circumference

The included lifestyle characteristics were smoking (Do you smoke? ("yes" or "no")), drinking alcohol (Do you drink? ("yes" or "no")), physical activity (How often do you take exercise? (always = more than 4 times a week; sometimes = 2- 4 times a week; hardly ever = 0 -1 times a week)), and breakfast (Do you have breakfast every day? ("yes" or "no")). In addition, body mass index (BMI) and waist circumference (WC) were assessed. Weight, height, and WC were measured in each subject. These measurements were carried out by trained nursing postgraduates using electronic scales (model SH-10XD) and flexible, inelastic belt-type tapes, respectively. Measurements were taken twice. Mean values of the two measurements were used for the analyses. BMI was calculated as the weight in kg divided by the square of the height in meters. Subjects were initially categorized into four BMI groups according to the World Health Organization guideline for Asians: underweight (<18.5 kg/m^2), normal weight (from 18.5 to 22.9 kg/m^2), overweight (from 23 to 24.9 kg/m^2), and general obesity (over 25 kg/m^2) [127]. Abdominal obesity was defined as a WC ≥ 90 cm in men and ≥ 80 cm in women [128,129].

Socio-demographic characteristics and disease

The socio-demographic characteristics measured were: age, gender, marital status (two categories: married/with partner or other (unmarried, divorced, or widowed)), educational level (five categories: no schooling, primary school, middle school, high school, or university), and monthly income (yuan) (four categories: <1000; 1000~1999; 2000~2999; 3000~). Five categories of disease, including four chronic diseases common in the Chinese population, were assessed using self-report: cardiovascular disease, cancer, chronic respiratory diseases, diabetes, or other diseases.[130] The total number of chronic diseases was used in our analyses.

Data analysis

Descriptive statistics were used to determine the characteristics of participants (N = 995). The data are presented as the mean ± SD and frequencies (percentages). Because the underweight group was small

(n = 5), this group is only included in the descriptive statistics and a single analysis (see below). Bivariate analyses were conducted to determine the associations between demographic characteristics, lifestyle characteristics, comorbid diseases, BMI, WC, multidimensional frailty, and three frailty domains (physical, psychological, social). The Chi-square test was used to compare the prevalence of frailty for categorical variables. One-way ANOVA analyses were selected to compare the detailed frailty scores (physical frailty, psychological frailty and social frailty) in categorical groups. We then carried out multiple linear regression analyses with the goal of determining the individual effects of BMI and WC on multidimensional frailty and its three domains, adjusted for other variables in the model (socio-demographic characteristics, lifestyle characteristics). All statistical analyses were performed with SPSS 20.0 (SPSS Inc., Chicago, IL, U.S.A.). The statistical significance level was set at $p < .05$.

Results

Participant characteristics

The characteristics of participants by BMI and WC category are shown in **Table 1**. A total of 995 subjects were recruited, 47.7% men and 52.3% were women. Mean age was 75.1 (± 7.38) and 82.0% were married or with partners. General obesity was found in 99 participants (9.9%) and 492 participants (49.4%) had abdominal obesity. The prevalence of multidimensional frailty and physical frailty was 46.5% and 45.1%, respectively. **Table 1** also presents the demographic and lifestyle characteristics based on the BMI and WC of the participants.

Table 1 Characteristics of participants by categories of BMI and WC (N=995)

Variables	BMI *n* (%)				WC (cm) *n* (%)	
	Under-weight 5 (0.5)	Normal 524 (52.7)	Overweight 367 (36.9)	Obese 99 (9.9)	<90 (M) <80 (W) 492(49.4)	≥90 (M) ≥80 (W) 503 (50.6)
Socio-demographic characteristics						
Age						
65-74	1 (20)	304 (58)	159 (43)	47 (48)	246 (50)	265 (54)
75-84	2 (40)	178 (34)	142 (39)	34 (34)	172 (34)	184 (37)
≥85	2 (40)	42 (8)	66 (18)	18 (18)	85 (16)	43 (9)
Gender						
Men	4 (80)	299 (57)	130 (35)	39 (40)	232 (46)	240 (49)
Women	1 (20)	225 (43)	237 (65)	60 (61)	271 (54)	252 (51)
Marital status						

Married/with partner	4 (80)	465 (88)	279 (76)	72 (73)	394 (78)	422 (86)
Others	1 (20)	65 (12)	88 (24)	27 (27)	109 (22)	70 (14)
Monthly income (yuan)						
<1000	1 (20)	90 (17)	61 (17)	17 (17)	113 (23)	55 (11)
1000-1999	1 (20)	219 (41)	130 (35)	49 (50)	195 (39)	133 (27)
2000- 2999	3 (60)	106 (20)	125(34)	29 (29)	137 (27)	160 (32)
≥3000	0 (0)	114 (22)	51 (14)	4 (4)	58 (11)	144 (29)
Educational						
No schooling	0 (0)	15 (3)	61 (17)	32 (32)	77 (15)	31 (6)
Primary school	2 (40)	34 (7)	138 (38)	45 (46)	133 (27)	86 (18)
Middle school	1 (20)	225 (42)	155 (42)	20 (20)	203 (40)	198 (40)
High school	2 (40)	166 (32)	9 (2)	0 (0)	66 (13)	111 (23)
University	0 (0)	84 (16)	4 (1)	2 (2)	24 (5)	66 (13)
Comorbid						
0	2 (40)	117 (22)	78 (21)	31 (31)	141(28)	87 (18)
1	2 (40)	141 (27)	110 (30)	18 (18)	146 (29)	125 (25)
≥2	1 (20)	266 (51)	179 (49)	50 (51)	216 (43)	280 (57)
Lifestyle characteristics						
Smoking						
Yes	4 (80)	178(34)	120 (33)	27 (27)	183 (36)	143 (29)
No	1 (20)	346 (66)	247 (67)	72 (73)	320 (64)	349 (71)
Drinking alcohol						
Yes	1 (20)	142(27)	126 (34)	49 (49)	185 (37)	133 (27)
No	4 (80)	382 (73)	241 (66)	50 (51)	318 (63)	359 (73)
Physical activity						
Always	4 (80)	251 (48)	182 (50)	47 (48)	211 (42)	273 (55)
Sometimes	1 (20)	148 (28)	111 (30)	35 (35)	198 (39)	97 (20)
Hardly ever	0 (0)	125 (24)	74 (20)	17 (17)	94 (19)	122 (25)
Breakfast						
Yes	5 (100)	508 (97)	359 (98)	96 (97)	478 (95)	490 (99.6)
No	0 (0)	16 (3)	8 (2)	3 (3)	25 (5)	2 (0.4)
Multidimensional frailty						
Yes	1 (20)	189 (36)	211 (58)	59 (60)	302 (60)	161 (33)
No	4 (80)	335 (64)	156 (42)	40 (40)	201 (40)	331 (67)
Physical frailty						
Yes	3 (60)	106 (20)	120 (33)	38 (38)	173 (34)	94 (19)
No	2 (40)	418 (80)	247 (67)	61 (62)	330 (66)	398 (81)

BMI = Body Mass Index; WC = Waist Circumference.

Associations between BMI, WC, and frailty

Table 2 presents the associations between socio-demographic characteristics, disease, lifestyle characteristics, BMI, WC and frailty. In terms of BMI category, subjects in the general obesity group had higher multidimensional frailty scores than subjects in the overweight group and the

underweight/normal group (5.82 ± 3.55 vs. 5.38 ± 3.31 vs. 4.05 ± 3.17, p < .001). Regarding categories of WC, obese subjects (men with WC > 94 cm, and women with WC > 80 cm) had higher frailty scores than other subjects (5.67 ± 3.49 vs. 3.74 ± 2.86, p < .001).

Table 2. Associations between socio-demographic characteristics, diseases, lifestyle characteristics, BMI, WC and frailty (N=990)

Variable	Physical frailty		Psychological frailty		Social frailty	
	(*m*,*SD*)	*p*	(*m*,*SD*)	*p*	(*m*,*SD*)	*p*
Socio-demographic Characteristics						
Age		<0.001		0.001		<0.001
65~74	1.74±1.82		1.07±1.18		0.93±0.86	
75~84	2.63±2.07		1.54±1.24		0.97±0.80	
≥85	3.81±1.88		2.06±1.10		1.50±0.90	
Gender		0.025		0.002		<0.001
Men	2.12±2.02		1.19±1.18		0.84±0.81	
Women	2.50±2.05		1.52±1.28		1.18±0.88	
Marital status		<0.001		<0.001		<0.001
Married/with	2.11±1.97		1.21±1.22		0.79±0.68	
Others	3.28±2.10		2.04±1.12		2.06±0.84	
Monthly income in yuan		<0.001		<0.001		<0.001
<1000	2.92±2.12		1.59±1.28		1.40±0.88	
1000~1999	2.65±2.12		1.49±1.29		1.11±0.90	
2000~2999	1.90±1.84		1.24±1.19		0.88±0.73	
≥3000	1.89±1.91		1.14±1.16		0.75±0.86	
Educational level		<0.001		<0.001		<0.001
No schooling	3.40±2.06		2.09±1.20		1.69±1.01	
Primary school	2.64±2.02		1.39±1.20		1.02±0.87	
Middle school	2.06±1.96		1.26±1.21		0.98±0.79	
High school	2.06±2.09		1.27±1.27		0.88±0.84	
University	1.90±1.84		1.04±1.18		0.90±0.84	
Comorbid diseases		<0.001		<0.001		<0.001
0	1.71±1.81		1.02±1.11		0.80±0.75	
1	2.43±2.01		1.56±1.31		1.08±0.89	
≥2	3.54±2.02		1.89±1.22		1.43±0.90	
Lifestyle characteristics						
Smoking		0.538		0.013		0.376
Yes	2.32±2.03		1.43±1.28		1.05±0.88	
No	2.30±2.09		1.22±1.16		0.95±0.83	
Drinking alcohol		0.414		0.678		0.086

Yes	2.21±2.02		1.34±1.25		0.98±0.84	
No	2.55±2.08		1.41±1.23		1.09±0.91	
Physical activity		0.001		<0.001		<0.001
Always	2.13±1.92		1.24±1.21		0.96±0.83	
Sometimes	2.81±2.20		1.73±1.24		1.21±0.90	
Hardly ever	2.08±1.99		1.14±1.22		0.89±0.85	
Breakfast		0.002		0.151		<0.001
Yes	2.29±2.02		1.34±1.24		1.00±0.86	
No	3.30±2.61		1.96±1.34		1.70±0.91	
BMI (kg/m^2)		<0.001		0.002		<0.001
Normal	1.93±1.90		1.23±1.20		0.85±0.80	
Overweight	2.70±2.08		1.51±1.25		1.18±0.89	
Obese	2.97±2.24		1.53±1.37		1.32±0.92	
WC (cm)		<0.001		<0.001		<0.001
>90 men >80 women	2.75±2.11		1.64±1.29		1.25±0.92	
≤90 men ≤80 women	1.87±1.88		1.07±1.12		0.78±0.73	

BMI = Body Mass Index; WC = Waist Circumference

Table 2. Associations between socio-demographic characteristics, diseases, lifestyle characteristics, BMI, WC and frailty (N=990) (continued)

Variable	Multidimensional frailty	
(*m*,*SD*)		*p*
Socio-demographic Characteristics		
Age		<0.001
65~74	3.73±3.05	
75~84	5.14±3.26	
≥85	7.37±2.91	
Gender		<0.001
Men	4.14±3.22	
Women	5.20±3.36	
Marital status		<0.001
Married/with partner	4.11±3.08	
Others	7.38±3.12	
Monthly income in yuan		<0.001
<1000	5.90±3.33	
1000~1999	5.26±3.42	
2000~2999	4.03±2.98	
≥3000	3.78±3.22	
Educational level		<0.001

No schooling	6.99±3.34	
Primary school	5.06±3.13	
Middle school	4.30±3.11	
High school	4.20±3.54	
University	3.84±3.12	
Comorbid diseases		<0.001
0	3.53±2.82	
1	5.07±3.32	
≥2	6.86±3.24	
Lifestyle characteristics		
Smoking		0.147
Yes	4.81±3.35	
No	4.48±3.30	
Drinking alcohol		0.008
Yes	4.53±3.26	
No	5.05±3.46	
Physical activity		<0.001
Always	4.32±3.00	
Sometimes	5.74±3.59	
Hardly ever	4.11±3.36	
Breakfast		0.011
Yes	4.63±3.30	
No	6.96±4.02	
BMI (kg/m^2)		<0.001
Normal	4.01±3.15	
Overweight	5.38±3.31	
Obese	5.82±3.56	
WC (cm)		<0.001
>90 men >80 women	5.65±3.49	
≤90 men ≤80 women	3.73±2.86	

BMI = Body Mass Index; WC = Waist Circumference

Regression analyses

Multiple linear regression analyses revealed that general obesity was only significantly positively associated with physical frailty (p = .018), adjusted for all socio-demographic and lifestyle characteristics in the model. Abdominal obesity was significantly positively associated with all four frailty variables (for multidimensional frailty, p < .001, for physical frailty, p = .001, for psychological frailty, p < .001, social frailty, p < .001), adjusted for all variables in the model (see **Table 3**).

The regression analyses also showed that older age was significantly positively associated with multidimensional frailty, physical frailty, and psychological frailty, while gender (women) was positively associated with multidimensional, psychological and social frailty. High monthly income

was negatively associated with social frailty. Comorbid diseases and an unmarried or without partner status were significantly positively associated with all frailty domains.

It is worth noting that among the lifestyle characteristics, drinking alcohol and eating breakfast were the only domains that significantly associated with three or two frailty variables, respectively. The R^2 values demonstrated that the variables in the model together explained a significant portion of the variance of multidimensional frailty (physical frailty, psychological frailty, and social frailty) (see **Table 3**).

Table 3. Effects of the socio-demographic and lifestyle characteristics on frailty: multiple linear regression analyses (N=990)

	Physical frailty			Psychological frailty			Social frailty		
	B	*SE*	*p*	*B*	*SE*	*P*	*B*	*SE*	*p*
Socio- demographic characteristics									
Age	0.090	0.008	<.001	0.039	0.005	<.001	0.004	0.003	.213
Gender	0.332	0.159	0.037	0.221	0.101	.029	0.269	0.062	<.001
Marital status	0.395	0.151	.009	0.468	0.096	<.001	1.034	0.059	<.001
Monthly income	-0.118	0.109	.275	0.016	0.069	.818	-0.138	0.042	.001
Education level	0.103	0.082	.206	-0.044	0.052	.397	0.061	0.032	.056
Co-morbid diseases	0.808	0.070	<.001	0.358	0.045	<.001	0.211	0.027	<.001
Lifestyle characteristics									
Smoking	0.197	0.159	.215	-0.089	0.101	.380	0.043	0.062	.488
Drinking alcohol	0.396	0.148	.008	0.234	0.094	.013	0.125	0.057	.030
Physical activity	0.064	0.070	.360	0.006	0.044	.898	0.004	0.027	.870
Breakfast	0.595	0.346	.086	0.349	0.220	.113	0.448	0.134	.001
Obesity									
General obesity	0.298	0.126	.018	0.053	0.082	.521	-0.018	0.050	.719
Abdominal obesity	0.398	0.118	.001	0.356	0.075	<.001	0.244	0.046	<.001
Constant	-7.622	0.888	<.001	-3.863	0.565	<.001	-1.796	0.336	<.001
R^2	0.297		<.001	0.228		<.001	0.437		<.001
Adjusted R^2	0.289		<.001	0.218		<.001	0.430		<.001

Table 3. Effects of the socio-demographic and lifestyle characteristics on frailty: multiple linear regression analyses (N=990) (continued)

	Multidimensional frailty		
	B	*SE*	*p*
Socio-demographic characteristics			
Age	0.132	0.012	<.001
Gender	0.486	0.179	.007
Marital status	5.837	1.502	<.001
Monthly income	-0.334	0.162	.040
Education level	0.174	0.122	.154
Co-morbid diseases	1.400	0.105	<.001
Lifestyle characteristics			
Smoking	-0.251	0.206	.223
Drinking alcohol	0.502	0.207	.016
Physical activity	0.105	0.104	.313
Breakfast	1.230	0.517	.018
Obesity			
General obesity	0.201	0.192	.296
Abdominal obesity	1.051	0.177	<.001
Constant	-15.010	1.957	<.001
R^2	0.409		<.001
Adjusted R^2	0.401		<.001

Discussion

Of the participants in our study, almost half (46.5%) showed multidimensional frailty. This outcome is higher than that reported by Dong et al.[131] (13.1%), a similar study but conducted in Jinan, a socioeconomically developed city in Eastern China, whereas our study in Zhengzhou, a still-developing city in central China, included older people with a lower educational level and lower monthly income compared to Jinan. Previous studies have shown that both of these important socioeconomic factors are associated with higher multidimensional frailty scores [132,133]. In our study, 45.1% of the participants experienced physical frailty, a prevalence figure much higher than that found in earlier studies conducted in China (12.4%) [131,132]. One possible explanation for the difference in findings was that our participants were older people (≥65 years old) with hypertension, while the participants in the other studies were below 65 years of age and with or without chronic diseases. Furthermore, the prevalence figures for physical frailty (45.1%) and multidimensional frailty (46.5%) were very similar and in line with our previous study in the Netherlands.[106]

Our results indicate that both general obesity and abdominal obesity are positively associated with physical frailty, a finding consistent with a previous report by Garcia-Esquinas et al.[134] The concordance with this earlier study may be due to the use of the phenotype of frailty, which measures physical frailty [135]. This phenotype consists of five domains, including weakness, slow walking speed, unintentional weight loss, exhaustion, and low physical activity; four of these criteria are also included in the TFI. However, a recent study suggested that the phenotype of frailty should be re-calibrated for people who are overweight and obese [136]. According to Boutin and colleagues, overweight and obesity reduce the risk of adverse outcomes in community-dwelling older women (death, fall risk, hip fracture). By contrast, a systematic review reported a positive relationship between BMI and physical frailty [137]. Thus, further studies of the association between general obesity or abdominal obesity and physical frailty are clearly needed.

We found that obesity was positively associated with physical frailty in older people with hypertension, a finding supported by a previous study [138]. Physical frailty is closely and negatively associated with medication adherence and treatment adherence in older people with hypertension [109,139,140]. Poor medication adherence and treatment adherence cause adverse outcomes such as hospitalization and disability. In turn, these adverse outcomes increase the prevalence of physical frailty. Second, in this study multidimensional frailty coexisted with hypertension in 46.5% of patients. Older people with hypertension who are either generally obese or abdominally obese have less muscle mass due to fat infiltration of the muscle and obesity-associated inactivity [141]. Older people with hypertension who are abdominally obese also have a high level of insulin resistance, which may in turn increase the risk of frailty [142]. Additionally, the ratio of fat mass to muscle mass or the amount of

visceral versus peripheral fat may be strongly associated with frailty. Our study also demonstrated that abdominal obesity was associated with psychological frailty and social frailty. To the best of our knowledge, this is the first study to investigate the association between obesity and multidimensional frailty, so the results could not be compared with previous studies regarding psychological and social frailty. However, associations between individual components of psychological or social frailty and obesity were investigated in earlier studies. One five-year observational study showed that general obesity at baseline was associated with an increased risk of depression five years later [143]. Another study showed that people who were obese had a higher risk of depression and anxiety. Depression and anxiety are closely associated with psychological frailty and social frailty [142]. Besides the emerging evidence on obesity and frailty, the distinction between the association between abdominal obesity and frailty and the association between general obesity and frailty has been largely unexplored.

In addition to the findings discussed above, a higher multidimensional frailty risk was found in the alcohol abstention group compared to the alcohol consuming group. Similarly, a recent longitudinal study in older people reported a lower incidence of functional limitations associated with alcohol intake versus abstention [144]. In addition, light-to-moderate alcohol consumption is reportedly protective against all-cause mortality and cardiovascular diseases [145]. The present study also showed that older people who do not eat breakfast tend to be multidimensional frail. One explanation could be that people without an appetite for breakfast have less motivation in terms of functional exercise and social interaction [146]. More detailed explanations should be explored in future studies. Our analyses also showed that the socio-demographic characteristics older age, gender (women), unmarried or without a partner, and high monthly income were associated with at least two of the four frailty variables. That unmarried or without a partner is associated with both multidimensional and social frailty is not surprising, because the TFI used for measuring multidimensional frailty includes living alone as a component of social frailty.

Some limitations of our study should be noted. First, most data were obtained by self-report, and recall errors may have resulted in some incorrect answers. Second, our data included possible confounders (e.g., regions, occupations), and we weren't able to rule out all possible confounding factors. This means that there may be some unavoidable selection bias in our study. Future large-scale studies should expand classifications to reduce this limitation. Third, we only included individuals with hypertension, which limits the generalizability of our findings. Finally, the cross-sectional design of this study does not allow strict cause-effect interpretations of the associations between obesity and multidimensional frailty.

Conclusion

Age-related multidimensional frailty is a daily reality for community-dwelling older people with hypertension. This study showed that abdominal obesity (thus a larger WC) is closely associated with increased risk for multidimensional frailty, while general obesity (a higher BMI) is associated with physical frailty in older people with hypertension. A better understanding of the associations between obesity and multidimensional frailty may help improve the health and quality of life of older people living with hypertension.