

Poor pelvic floor health is associated with frailty in 40–75 year olds

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ABSTRACT

To determine the associations between pelvic floor health and frailty, and to identify variables associated with them, this study involved 656 community-dwellers aged 40–75 years who participated in a cross-sectional observational study. Participants completed the Pelvic Floor Bother Questionnaire and the Fried frailty phenotype assessment, and were assessed for putative predictors (sleep quality, body mass index, nutrition, psychological distress, hydration, smoking, alcohol, polypharmacy and health concerns). Differences were tested using analysis of variance models and chi square tests, and associations were tested using linear and logistic regression models. Bladder and bowel concerns were reported by men and women in all age groups, and 38% of participants exhibited at least one frailty element. There was a significant association between reporting frailty elements and poor pelvic floor health, and both were significantly associated with increasing age for men and women, poor sleep quality and high body mass index. Only pelvic floor health was significantly associated with health concerns and polypharmacy, and only frailty was significantly associated with smoking and alcohol consumption. Significant associations with alterable lifestyle and general health factors suggest that early interventions to improve pelvic floor health could impact on health and healthy ageing more broadly.

Keywords pelvic floor, ageing, frailty, middle aged

INTRODUCTION

Approximately 21% of Australians aged 15 years and over report urinary incontinence (UI) (4.2 million) and/or faecal incontinence (FI) (1.3 million)¹. Prefaced on population ageing, the frequency of UI and FI is estimated to increase to 27% by 2030².

Female UI is associated with childbirth (muscle and nerve damage), pelvic organ prolapse, pelvic muscle weakness, and age-related deterioration in tissue structure and function³. Male UI is usually related to health concerns associated with ageing, such as enlarged prostate gland³. Compromised faecal health includes stool leakage, uncontrolled expulsion of faecal gas, and constipation, with prevalence ranging from 2.8–30.7%^{3,4}. Faecal incontinence is not considered as a direct physiological consequence of ageing⁴. However, both UI and FI are associated with poor health and lifestyle behaviours, such as inadequate hydration, poor diet and exercise patterns, and reduced mobility⁵.

Public understanding of UI and FI is generally poor, even in health-literate people⁶. This potentially leads to under-reporting of pelvic floor health (PFH) problems and may explain why 50–70% people who report UI do not seek professional help^{1,2}. Embarrassment and social stigma add to UI and FI under-reporting⁷, masking true prevalence^{1,2}. Over half (52.9%) of women with UI

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Conflict of interest

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believe it was inevitable with age, 22% believed they should cope with the problem themselves, and 14% thought no useful treatment was available⁹. Ultimately, UI and FI are common reasons for eventual admission to residential aged care⁹.

Proposed predictors of UI and FI include high BMI^{5,7}, parity, coughing, osteoporosis and arthritis, gender, low health literacy¹⁰, heavy lifting¹⁰, poor hydration¹¹, poor diet¹² and smoking¹³. Moreover, UI has been associated with frailty^{14,15} via common factors including older age, multiple medical conditions and polypharmacy, psychological distress, and poor self-assessed health¹⁶⁻¹⁹.

Most frailty research has been conducted on people aged 65 years and over¹⁸, a decision variably based on government census population categories, retirement age, pension eligibility, and beliefs that frailty is an issue for older adults only^{20,21}. This focus does not incorporate the notion that individual functional deficits can commence earlier (for instance, in middle age), and accrue over time¹⁸. While it is accepted that changes in function occur with increasing age, it is not age per se that determines the trajectory of frailty, rather a combination of factors related to genetic inheritance, lifestyle choices, attitude, sociodemographic variables and luck^{16,20,22}. It is increasingly recognised that some 70 year olds may function as well as someone aged 55 years, whilst some 55 year olds may function in the manner of someone much older^{16,18,20-22}.

The relationship between PFH, frailty and measures of wellbeing, health, physiology and function has not been explored in people younger than 65 years. Moreover, frailty assessments for older people inconsistently include pelvic floor function²³. Thus, if the Australian estimates of UI and FI are to be believed, and if poor PFH is a precursor for frailty, then improving pelvic floor performance in middle age may prevent or delay progression to frailty as people age.

METHODS

Ethics approval was obtained from Southern Adelaide Local Health Network (South Australia) (391.16). This paper conforms to the principles embodied in the Declaration of Helsinki. Return of online surveys implied consent. All participants provided signed consent prior to objective assessment which included use of data for publication.

A cross-sectional, observational study was designed with the aim to explore associations between poor PFH and frailty in order to estimate the impact of putative predictors for both poor PFH and frailty (age, sex, diet, hydration, body mass index (BMI), sleep quality, regular medications, tobacco smoking, overall health, and psychological stress).

Direction of association

Poor PFH was the primary exposure for frailty. Associations between PFH and frailty were assessed in gender-age categories because of known gender differences in PFH³, and the known effect of increasing

age³ on PFH and frailty⁴. Diet, hydration, BMI, sleep quality, regular medications, alcohol consumption, tobacco smoking, overall health, and psychological distress were analysed as independent suggested predictors of both PFH and frailty⁵.

Sampling and data collection

We previously provided detailed information on the sampling approach and study methods²⁴. In summary, the sample included 656 volunteers recruited in 2017–2018 from three large municipal councils, staff of metropolitan branches of a national bank, and staff at a large university. Recruitment occurred by multiple initiatives, including email invitation, local media messages, posters, presentations by researchers to community groups, and snowballing (asking interested participants to invite friends and family)^{22,24}. Consenting participants completed self-reported measures (online or on paper), and attended local testing stations where researchers completed physical assessments²⁴.

Sample size estimate

As there is scant information on the prevalence of poor PFH or frailty in community-dwelling Australians aged 40–75 years, broad estimates were extrapolated from the literature. We used the CDC Epi Info™ sample size calculator for population studies to estimate a minimum sample size²⁵. We assumed a local reference population size from the most recent census figures of 500,000 adults aged 40–75 years in the city where this research was conducted. We applied estimated prevalence in the youngest age group (40–49 years) of any symptom of poor bladder or bowel health of 30%^{3,4}, and 5% prevalence of three or more elements of frailty²⁶, margin of error 5%, 80% power, and four age clusters (40–49 years; 50–59 years; 60–69 years; 70+ years). At least 60 participants were required in each cluster to confidently assess prevalence of PFH and frailty. As the study examined multiple associations which incurred potential Type 1 errors²⁷, we sought to recruit at least 120 participants in each age cluster (minimum sample of 480).

The Pelvic Floor Bother Questionnaire (PFBQ) is a psychometrically-sound instrument developed to identify, and assess severity of, pelvic floor concerns²⁸. The PFBQ contains questions regarding: urine leakage, urgency, frequency and discharge; constipation and faecal leakage; and dyspareunia (pain during sexual intercourse). For each item, respondents note concern=1, no concern=0, and then rate the level of bother with each concern ('not at all' (0) to 'a lot' (4))²⁴. This paper reports only the five bladder (urine leakage during physical activities; frequency of urination; urgency to urinate; leakage associated with urgency; discomfort on urinating) and two bowel (constipation; faecal gas) health questions relevant to both men and women; the female-only questions on pelvic bulging and dyspareunia were excluded. To provide an overall summary of PFH for ease of describing the problem, we combined the bladder and bowel health measures into pelvic floor concerns and pelvic floor bother measures. However, we largely kept bladder and bowel measures

separate for analysis, on the understanding that they may exert different impacts on frailty elements.

Frailty assessment

We established individual frailty scores by summing binary scores assigned to each Fried frailty phenotype element¹⁶ – unintentional weight loss in the past 6 months, low regular exercise and exhaustion (all self-reported) – and objectively measured poor grip strength and slow walking pace. Low regular exercise was determined as less than the median Australian recommended time spent walking per week, and no moderate and vigorous exercise²⁹. Exhaustion was self-reported as item 1 in the 10-item psychological distress questionnaire K10³⁰. Grip strength was measured in sitting by dynamometry, and poor grip strength was determined as measures lower than age-gender population norms³¹. Slow walking pace was determined as measures above the 80th percentile distribution of the difference between actual walking speed and age-gender population norms for the Six Minute Walk Test (6MWT)³².

Putative predictor variables

Age was calculated in parts of years from date of birth. *Gender* was self-nominated as male or female. *Psychological distress* was the sum of items 2–10 in the K10³⁰ (item 1 Exhaustion was already included in Fried frailty phenotyping); the higher the score, the greater the psychological distress. *BMI* was calculated from height (metres) and weight (kilograms). A *food intake score* was calculated from an Australian food behaviours survey³³, in which daily good food choices included eating: five or more vegetable serves; two or more fruit serves; mostly wholegrain fibre daily and an alternative cereal weekly; at least two serves of dairy; and one or more servings of lean meat. Poor food choices were regularly consuming sugary drinks, processed foods and takeaways. Higher food intake scores indicated better nutrition. *Hydration* was self-reported as ‘drinking plenty of water’ (or not)³³. *Sleep quality* was measured by the Pittsburgh Sleep Quality Index (PSQI)³⁴ where higher scores indicated poorer sleep quality. Smoking was self-reported, as was *medication* (the number of regular medications), and *general health* (overall health concerns).

Data management

The seven relevant PFBQ items (five bladder, two bowel) were each reported as 1=concern, 0=no concern²⁸. Total bladder and bowel concern scores were derived by summing the relevant binary responses (bladder concerns possible total 5, bowel concerns possible total 2). For every bladder or bowel concern, the PFBQ captured a bother score ranging from 0 (not at all) to 4 (a lot). Bother scores were calculated by multiplying each concern by the amount of reported bother. To avoid misinterpretation when multiplying a concern (scored 1) by the no bother score (0), we added 1 to each bother score (0+1, through to 4+1). We then calculated total bladder bother and total bowel bother subscores (total bladder bother score minimum=5,

maximum=25; total bowel bother score minimum=2, maximum=10).

Participants were classified *not frail* if they reported no Fried frailty phenotype element, *pre-frail* if they reported one or two elements, and *frail* if they reported three or more elements¹⁶.

Age was reported as a scaled variable and in 9-year categories (40–49 years, 50–59 years, 60–69 years, 70–75 years). Eight gender-age subgroups were established for stratum-specific analysis (males aged 40–49 years, females aged 40–49 years etc).

Classification of variables

Scaled variables were total bladder and bowel concerns, total bladder and bowel bother scores, age, psychological distress, BMI, food intake and sleep quality. Categorical variables were: frailty (not frail, pre-frail, frail); adequate hydration (Yes, No); concerns about general health (Yes, No); current smoking (Yes, No); and regular medications (none, 1–4, and 5+)³⁵.

Data analysis

Overall bladder and bowel health scores were reported descriptively (means, Standard Deviations (SD), median, 25th and 75th percentile, interquartile range (IQR), Shapiro-Wilks test of normal distribution, p values). All study measures were described as means for scaled measures (SD), or percentages (for frequency), in age-gender categories. Differences between age-gender categories were tested by Analysis of Variance (ANOVA) models for scaled variables, or chi square (chi²) tests for categorical variables. The likelihood of any bladder or bowel concern being reported in each gender-age group was tested using odds ratios (OR) (95%CI), with the reference category being men aged 40–49 years.

Mean total bladder and bowel concerns, and total bladder and bowel bother scores were calculated for the three frailty categories (Table 3), and differences across categories were tested by ANOVA models. Frequency of categorical variables were tested for each frailty category (Table 4) and differences between categories were established by chi square tests. Mean (SD) total bladder and bowel concerns and bowel bother scores were calculated for categorical variables of regular medication use, adequate hydration, smoking, alcohol consumption and health concerns overall, and in gender-age subgroups. Binary categories of frailty (with the reference category being no frailty) were compared in gender-age group categories using logistic regression models, with the output reported as OR (95%CI).

Measures of PFH (total bladder and bowel concerns, and total bladder and bowel bother scores) were tested in linear regression models as the dependent variables, to determine associations with scaled predictor variables (sleep quality, nutrition, BMI). The output was reported as *r*² values, F values, degrees of freedom (df) and p values overall, and then deconfounded by gender and age. We reported the mean bladder and bowel

measures for each level of each categorical predictor variable, with differences reported as F values, df and p values.

Significance

Associations were considered to be significant if 95%CI around OR did not include 1. Findings from ANOVA models or chi square tests were significant if the F value for the degree of freedom was greater than the threshold value, and the associated p value was <0.05. Findings from linear regression models were significant if the r² value was greater than 5%, the F value for the degree of freedom was greater than the threshold value, and the associated p value was <0.05.

Statistical software

Analyses were conducted using CDC Epi Info™ Version 7.2.3.1²⁵ and SAS Version 9.4³⁶.

RESULTS

Sample

There were 656 participants (66.76% female; mean age 59.94 years (SD 10.62)). The sample compared well with local age and gender population estimates, and local socioeconomic indices³⁷.

Pelvic floor health

Descriptive statistics for estimates of PFH for the entire sample are reported in Table 1. None of the frequency distributions for the four PFH measures was normally distributed, as evidenced by Shapiro-Wilks statistics <0.90 and significant p values. Transforming these distributions by squaring or log transformation did not significantly improve their normality, thus these variables were applied to linear regression models in their natural form, with caveats on interpreting the outputs³⁸.

Gender-age group differences

The mean values, SD, minimum and maximum

values of each scaled variable in gender-age group categories are reported in Table 2a and Table 2b. There were significant positive differences across the gender-age groups in all scaled measures except BMI (F=1.82 (p=0.12)). The significant measures were the total number of bladder concerns (F=4.51, p<0.001), total number of bowel concerns (F=4.14, p<0.001); total bladder bother score (F=4.17, p<0.001); total bowel bother score (F=3.43, p<0.001); sleep quality (F=2.33, p=0.02); nutrition (F=11.42, p<0.001) and psychological distress (F=11.62, p=0.002).

PFH according to age

Men and women in each age group reported poor PFH in terms of bladder as well as bowel concerns. There was a significant overall increase in the frequency of bladder concerns reported by men as they aged (chi² for trend 11.22, df=1, p<0.001); however, this same pattern was not observed for women (chi² for trend 1.17, df=1, p=0.31)). This suggests that the rate with which women reported any bladder concern remained relatively constant as they aged. Whilst at least one bowel problem was also reported in each gender-age group, there was no significant increase in frequency with increasing age (chi² for trend 3.55 df=1 p=0.06) for men; 2.32, df=1, p=0.13) for women). The gender-age group numbers, frequencies and OR (95%CI) for any bladder or bowel concern are reported in Table 3. The frequency with which the number of PFH concerns was reported overall in the sample, and by men and women, is described as percentages in Figure 1.

Differences across gender-age categories for categorical variables

The gender-age frequencies of categorical variables are reported in Table 4. There were significant gender-age differences across all but one categorical variable (smoking (chi²=10.22, df=7, p=0.17)). The variables with significant gender-age differences were frailty chi²=29.56, df=14, p=0.009; health concerns chi²=56.34 df=7, p<0.001; alcohol chi²=40.84, df=14,

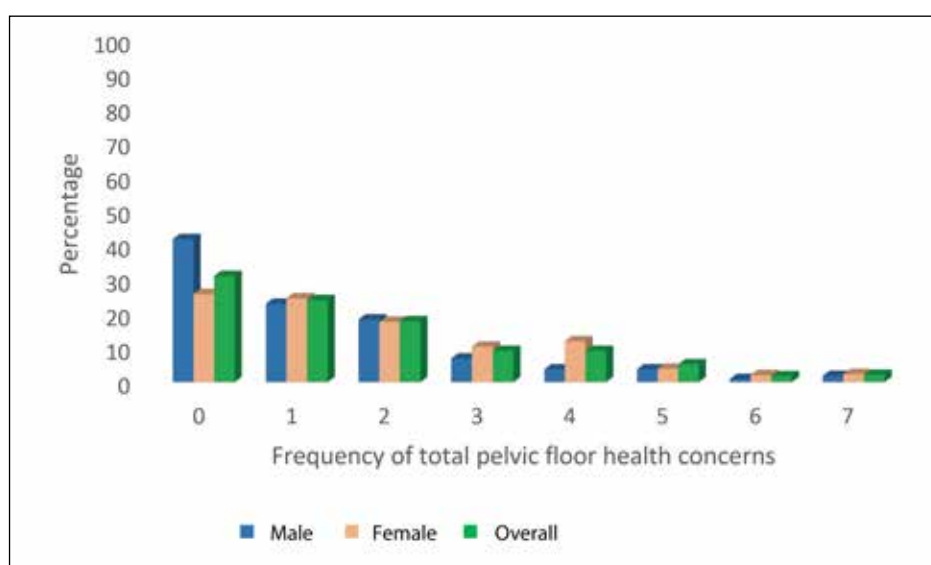


Figure 1. Frequency of total PFH concerns for male, female and overall

Table 1. Descriptive statistics for PFH (bladder and bowel)

	Mean	SD	Median	25th	75th	Min	Max
Total bladder concerns	1.33	1.43	1	0	2	0	5
Total bowel concerns	0.45	0.62	0	0	1	0	2
Total bladder bother scores	3.45	4.43	2	0	5	0	25
Total bowel bother scores	1.01	1.92	0	0	2	0	10

Table 2a. Values in age group categories: males

Variable	Male 40-49 years			Male 50-59 years			Male 60-69 years			Male aged 70+ years					
	n	Mean	SD	Minimum	Maximum	n	Mean	SD	Minimum	Maximum	n	Mean	SD	Minimum	Maximum
Bladder concerns	61	0.72	1.05	0	4	46	0.84	1.22	0	5	68	1.34	1.45	0	5
Bowel concerns	61	0.13	0.42	0	2	46	0.17	0.45	0	2	68	0.36	0.66	0	2
Bladder bother	61	1.87	2.41	0	9	46	1.86	3.34	0	17	68	3.48	4.32	0	17
Bowel bother	61	0.34	0.91	0	4	46	0.34	1.13	0	5	68	0.87	1.73	0	9
Sleep quality	58	6.16	2.57	2	14	44	4.58	2.95	0	15	61	5.04	3.76	0	16
Nutrition	61	3.08	2.96	0	9	46	3.72	3.14	0	9	68	4.93	2.87	0	9
BMI	61	27.53	3.71	20.71	40.32	46	28.5	3.6	20.92	38.76	66	27.08	3.79	20.73	36.24
Psychological distress	57	0.53	0.72	0	3	46	0.62	0.77	0	2	68	1.2	1.24	0	9

Table 2b. Values in age group categories: females

Variable	Male 40-49 years			Female 50-59 years			Female 60-69 years			Female aged 70+ years					
	n	Mean	SD	Minimum	Maximum	n	Mean	SD	Minimum	Maximum	n	Mean	SD	Minimum	Maximum
Bladder concerns	79	1.34	1.35	0	5	110	1.34	1.33	0	5	139	1.54	1.48	0	5
Bowel concerns	79	0.43	0.72	0	2	110	0.43	0.64	0	2	139	0.55	0.73	0	2
Bladder bother	79	2.92	3.63	0	18	110	3.65	4.69	0	20	139	3.97	4.98	0	19
Bowel bother	79	0.93	1.51	0	6	110	1.13	2.14	0	10	139	1.53	2.33	0	10
Sleep quality	74	5.81	2.97	1	13	108	5.82	2.92	1.0	14	134	5.02	3.32	0	14
Nutrition	75	3.44	3.34	0	9	110	4.14	3.13	0	9	139	5.23	2.93	0	9
BMI	79	26.67	4.82	18.55	42.76	108	28.47	6.45	17.8	50.9	139	27.14	5.22	18.24	46.27
Psychological distress	79	0.96	1.24	0	7	110	0.89	0.94	0	5	139	1.32	1.13	0	8

Table 3. Risk of any bladder or bowel concern occurring in each age group

	Bladder concerns				Bowel concerns			
	n	Total n	%	OR (95%CI)	n	Total n	%	OR (95%CI)
Women	438	656	66.8		438	656	66.8	
Age 40-49 years (reference)	48	79	60.8		25	79	31.6	
Age 50-59 years	75	110	68.2	0.73 (0.41-1.28)	36	110	35.5	0.92 (0.45-1.75)
Age 60-69 years	95	139	68.3	0.85 (0.44-1.57)	57	139	41.0	1.44 (0.82-2.38)
Age 70+ years	78	110	70.9	0.93 (0.52-1.69)	45	110	40.9	1.45 (0.74-2.56)
Men	218	656	33.2		218	656	33.2	
Age 40-49 years (reference)	24	61	39.2		8	57	14.0	
Age 50-59 years	23	46	50.0	1.24 (0.49-2.53)	5	50	10.0	0.68 (0.21-2.23)
Age 60-69 years	42	68	61.8	2.23 (1.15-4.63)	18	68	26.5	2.24 (0.97-5.48)
Age 70+ years	31	43	72.1	3.59 (1.54-8.32)	10	43	23.3	1.25 (0.56-3.98)

Significant associations are bolded; associations that are trending towards significance are bolded in italics. Percentages are rounded

Table 4. Age group frequencies of categorical variables (n=656)

Variable	40-49 years		50-59 years		60-69 years		75+years	
	Male n=61	Female n=79	Male n=46	Female n=110	Male n=68	Female n=139	Male n=43	Female n=110
	n (%)*	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Pre-frail	25 (41)	47 (49)	21 (56)	53 (48)	25 (38)	50 (36)	16 (37)	38 (35)
Frail	2 (3)	1 (1)	1 (2)	2 (2)	5 (7)	3 (2)	1 (2)	6 (5)
Non-smoking	55 (90)	70 (89)	45 (98)	109 (99)	65 (96)	134 (96)	43 (100)	109 (99)
Health concerns	27 (44)	37 (47)	29 (63)	67 (58)	45 (66)	106 (78)	34 (79)	97 (88)
<10 drinks/week	33 (54)	45 (57)	22 (48)	72 (61)	37 (54)	75 (54)	21 (49)	59 (54)
10+ drinks/ week	17 (28)	6 (8)	13 (28)	8 (7)	13 (19)	18 (13)	14 (33)	14 (13)
Adequate hydration	21 (34)	29 (37)	17 (37)	51 (46)	33 (49)	85 (61)	22 (51)	73 (66)
1-4 medications	19 (31)	33 (42)	26 (57)	66 (60)	48 (71)	110 (79)	32 (74)	95 (86)
5+ medications	0 (0)	3 (4)	0 (0)	1 (1)	1 (1)	2 (1)	0 (0)	4 (4)

* Percentages are rounded

p<0.001; hydration chi²=32.77, df=14, p=0.001; regular medications chi²=96.62, df=14, p<0.001). In general, as people aged, their scores became poorer in all these variables.

Frailty: No frailty element was reported by N=359 participants (54.72%) (determined as 'not frail'). One or two elements (pre-frail) were reported by N=276 participants (42.07%) and three or more elements (frail) were reported by N=19 participants (2.89%).

Differences across frailty categories for scaled variables

The mean values, SD, minimum and maximum values for each scaled variable in each frailty category are reported in Table 5. There were significant differences across frailty categories for six variables: age (F=11.92, df=2, p<0.001); total bladder concerns (F=4.87, df=2, p=0.009); total bowel concerns (F=9.46, df=2, p<0.001); total bowel bother concerns (F=12.14, df=2, p<0.001); sleep quality (F=21.36 df=2 p<0.001); and BMI (F=3.85, df=2, p=0.02). In general, the scores for these predictor variables became poorer as the number of frailty elements increased. The differences

trended towards significance for total bladder bother scores (F=3.01, df=2, p=0.05), but there were no significant differences across frailty categories for nutrition (F=1.15, df=2, p=0.3) or psychological distress (F=0.97, df=2, p=0.4).

Differences across frailty categories for categorical variables

The frequency with which categorical variables occurred in frailty categories is reported in Table 6. There were significant differences across frailty categories only for smoking (chi²=9.42, df=3, p=0.009); and alcohol intake (chi²<0.001, df=4, p=0.002). There were no differences across frailty categories for gender (chi²=0.97, df=2, p=0.63); health concerns (chi²=1.95, df=2, p=0.39); hydration (chi²=2.94, df=2, p=0.23); or regular medications (chi²=1.35, df=4, p=0.8).

Frailty in gender-age groups

The frequency with which frailty elements were reported, and the odds of any frailty element (95%CI) being reported, did not change significantly with increasing age for men (chi² for trend 0.52, df=3,

$p=0.55$), but they did change for women (χ^2 for trend 11.91, $df=3$, $p=0.001$). For men, there was no significant change in risk when comparing the frailty elements in progressively older age groups, compared with the reference youngest age group. However, for women, each progressively older age group had significantly protective odds of any frailty element being reported compared with the youngest age group (Tables 7 & 8).

Increasingly poor PFH across frailty categories, using 95%CI around the means of total bladder, total bowel and total PFH concerns, and total bladder, total bowel and total pelvic floor bother scores are illustrated in Figure 2. There was considerable variability in scores as indicated by the width of the 95%CI, particularly for pelvic floor bother scores. The measure that provided the clearest indication of decreasing PFH with increasing frailty was total bladder concerns.

Associations between PFH and scaled predictor variables

The crude associations between all PFH and scaled predictor variables, and adjusted associations by age and gender, are reported in Table 9. Sleep quality was significantly associated with all four PFH measures in both crude and adjusted forms (sleep quality decreased as PFH decreased). BMI was significantly associated

with bladder health measures in both crude and adjusted forms, and with bowel health only in adjusted form (BMI increased as PFH decreased). Nutrition and psychological distress were not associated with any PFH measure in crude form, but all associations became significant after adjusting by age and gender.

Associations between PFH and categorical predictor variables

Table 10 reports the mean scores (SD) for PFH measures and categorical variables. There was a significant difference between bowel bother scores for smoking (or not) ($F=5.25$, $df=1$, $p=0.03$) (more bowel bother found for smokers). No other PFH measure was affected by smoking (bladder concerns $F=0.34$, $df=1$, $p=0.6$; bladder bother $F=2.94$, $df=1$, $p=0.08$; bowel concerns $F=1.18$ $df=1$, $p=0.3$). Expressing health concerns was reflected in significant differences in bladder and bowel concerns, and bowel bother, respectively $F=11.13$, $df=1$, $p<0.001$; $F=14.42$, $df=1$, $p<0.001$; $F=4.43$, $df=1$, $p=0.003$) (more health concerns expressed by people with poorer PFH). There was no difference in bladder bother with, or without, health concerns ($F=1.91$, $df=1$, $p=0.2$). There were no significant differences in any PFH measure for hydration (sufficient, not) and alcohol intake (none, 1–9 drinks per week, 10+ per week).

Table 5. Variables in frailty categories

Variable	n	Mean	SD	Minimum	Maximum
Not frail (no elements reported)					
Age	351	61.45	10.17	39.24	74.75
Total bladder concerns	351	1.32	1.38	0	5
Total bowel concerns	351	0.37	0.61	0	2
Total bladder bother score	351	3.22	4.16	0	19
Total bowel bother score	351	0.84	1.65	0	10
Sleep quality	309	4.72	2.83	0	14
Nutrition	351	4.54	3.22	0	9
BMI	350	27.17	5.06	18.26	47.15
Psychological distress	351	1.14	1.12	0	9
Pre-frail (1-2 elements reported)					
Age	282	57.86	10.91	39.69	75.06
Total bladder concerns	282	1.46	1.42	0	5
Total bowel concerns	282	0.44	0.78	0	2
Total bladder bother score	282	3.64	4.62	0	20
Total bowel bother score	282	1.23	2.14	0	9
Sleep quality	250	6.13	3.26	0	15
Nutrition	282	4.62	2.94	0	9
BMI	282	28.07	4.94	17.83	47.96
Psychological distress	282	1.04	1.15	0	8
Frail (3 or more elements reported)					
Age	20	62.77	9.12	41.04	75.07
Total bladder concerns	21	2.23	1.92	0	5.0
Total bowel concerns	21	0.97	0.83	0	2.0
Total bladder bother score	21	5.56	5.78	0	17.0
Total bowel bother score	21	2.87	3.12	0	10.0
Sleep quality	17	7.66	3.63	3	16.0
Nutrition	20	5.52	2.13	0	9.0
BMI	21	29.21	7.56	18.02	50.97
Psychological distress	20	1.34	0.83	0	2

For adequate hydration, ANOVA outputs were, respectively, bladder concerns (F=0.01 df=1 p=0.9;2 bowel concerns (F=0.02, df=1, p=0.94; bladder bother F=0.17, df=1, p=0.76; bowel bother F=0.26, df=1, p=0.73). For alcohol intake, ANOVA outputs were respectively, bladder concerns (F=1.35, df=2, p=0.37; bowel concerns (F=1.66, df=2, p=0.22; bladder bother F=0.42, df=2, p=0.78; bowel bother F=1.04, df=2, p=0.47). There were significant differences for all PFH measures and regular daily medication frequency (none, 1-4 daily. 5+ daily) (bladder concerns F=4.48, df=2, p=0.01; bowel concerns (F=5.65, df=2, p=0.004; bladder bother F=4.94, df=2, p=0.008; bowel bother F=5.98, df=2, p=0.003). Polypharmacy (5+ regular medications) was associated with poorer PFH.

DISCUSSION

This is the first study to investigate the relationship between frailty and PFH in community-dwelling adults aged 40-75 years. This sample is mostly younger than those recruited for frailty research. Our sample is generalisable to similarly-aged Australians in other cities, and the PFH and frailty findings concur with international studies^{1-3,22}. Concurring with other studies of similar ages, symptoms of poor PFH were found in all gender-age groups^{2,4,5}.

Over 40% of participants overall, and at least 38% participants in any gender-age subgroup, exhibited one or more frailty elements¹⁶. This concurs with recent large-scale population findings in the United Kingdom, suggesting that pre-frailty occurs regularly in middle-age²¹. Moreover, our findings of significant relationships between increasing frailty and decreasing PFH concur with other research^{14,15}. This lends weight to the inclusion of PFH questions in comprehensive frailty assessments²³.

A summary of the relationships between variables assessed in this study is shown in Figure 3. We found clear evidence that poor PFH is an important exposure for frailty elements for both genders. Both poor PFH and frailty share common predictors for both men and women (increasing age, poor sleep quality, high BMI). However, only poor PFH was associated with health concerns and polypharmacy, whilst only frailty was associated with smoking and regular alcohol intake.

In light of the complex epidemiology of frailty^{16,18,20,21}, the roles of PFH and sleep quality require further investigation in middle aged and ‘young’ old people to determine how it impacts on frailty predictors. We could not explore how poor PFH is associated with sleep quality, as nocturia was not measured. Nocturia can result from medical conditions, not just pelvic floor function^{3,5,7,9,10}. Targeted research is required to understand the factors related to poor sleep quality and psychological distress, and how these factors relate to PFH and frailty.

The concerning number of men and women in their 40s and 50s who reported poor PFH suggests that interventions could be effective for those whose pelvic floor structures are still sufficiently healthy for function to be retrained^{5,7,8,14}. This may possibly prevent progression to chronicity. However, reasons

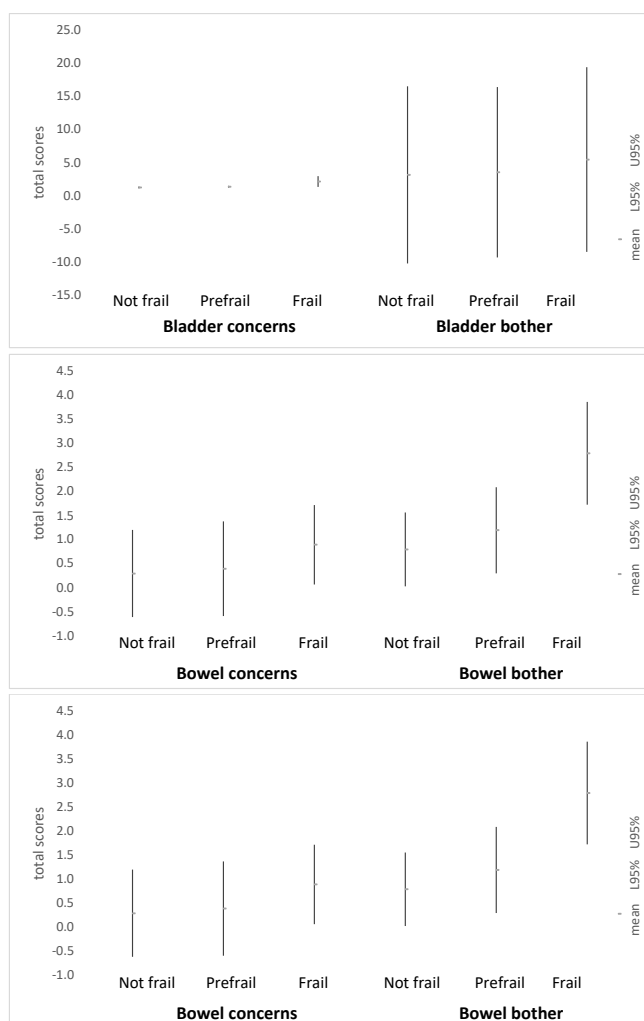


Figure 2. Mean scores for bladder, bowel and total PFH (95%CI) in frailty categories

Table 6. Frequencies of categorical variables in frailty categories

Variable	Not frail n=359	Pre-frail n=276	Frail n=21
	n (%)*	n (%)	n (%)
Male	121 (33)	88 (33)	9 (47)
Female	238 (67)	188 (67)	12 (53)
Non-smoker	345 (98)	262 (92)	17 (89)
Smoker	6 (2)	18 (6)	1 (5)
Health concerns	236 (67)	186, (67)	17 (89)
No health concerns	115 (33)	94 (33)	2 (11)
No alcohol	81 (23)	101 (36)	5 (26)
<10 drinks/week	215 (61)	139 (49)	8 (42)
10+ drinks/week	55 (16)	41 (15)	6 (32)
Adequate hydration	168 (48)	149 (53)	13 (68)
Inadequate hydration	183 (52)	132 (47)	6 (32)
No medication	112 (32)	98 (35)	7 (37)
1-4 medications	233 (66)	178 (63)	12 (63)
5+ medications	6 (2)	5 (2)	0

Missing data n=4

*Percentages are rounded

Table 7. Frequency of frailty indicators in age groups

Gender / Age group	Total n	No symptoms n (%)*	1-2 symptoms n (%)	3+ symptoms n (%)	Any frailty symptom n (%)
Male					
40-49 years	61	33 (49)	26 (42)	2 (3)	28 (46)
50-59 years	46	24 (59)	21 (46)	1 (2)	22 (45)
60-69 years	68	38 (54)	25 (37)	5 (7)	30 (44)
70+ years	43	26 (61)	16 (37)	1 (2)	17 (40)
Female					
40-49 years	79	31 (33)	47 (60)	1 (1)	48 (61)
50-59 years	110	60 (56)	53 (48)	2 (2)	55 (50)
60-69 years	139	55 (62)	50 (36)	3 (2)	53 (38)
70+ years	110	66 (60)	38 (35)	6 (6)	44 (40)

*Percentages are rounded

Table 8. Any frailty symptoms being reported in age groups

Gender / Reference age group	Comparison age group	OR (95%CI)	Chi ² for trend
Men			
40-49 years	50-59 years	0.92 (0.44-1.89)	0.53 (p=0.05)
	60-69 years	0.94 (0.41-1.87)	
	70+ years	0.75 (0.32-1.68)	
Women			
40-49 years	50-59 years	0.54 (0.32-0.93)	11.92 (p<0.001)
	60-69 years	0.36 (0.24-0.59)	
	70+ years	0.43 (0.19-0.76)	

Significant associations are bolded

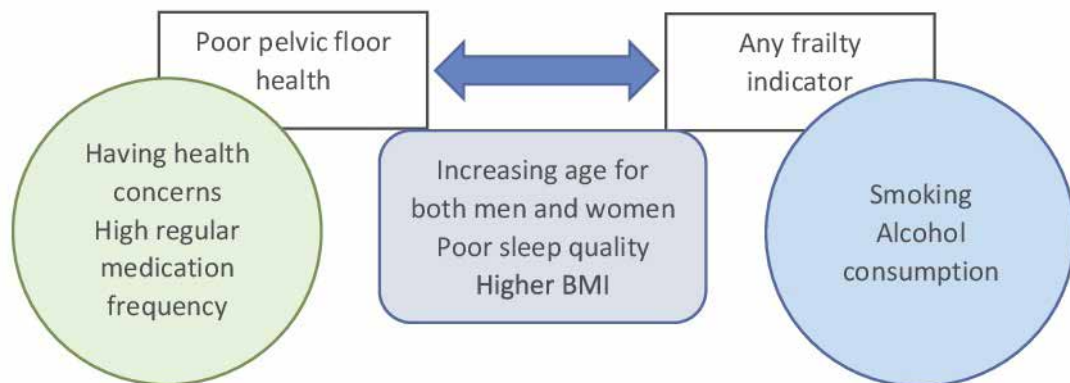


Figure 3. Relationship between PFH and frailty indicators, showing significant predictor variables

for poor performance of pelvic floor structures in middle-aged people needs to be better understood before effective interventions can be determined. The importance of poor sleep quality and high BMI on both frailty elements and PFH in our study suggests a sound starting point for public health education. High BMI is usually associated with an imbalance between exercise and food intake³⁹. Inadequate exercise is one of the five Fried frailty elements, whilst nutrition was not associated with frailty or PFH in our study. High BMI may affect PFH by increasing biomechanical and gravitational pressures on pelvic floor structures, and it may explain why individuals do not exercise as often

as guidelines recommend (perhaps resulting in slower walking speeds, poor grip strength and/or feeling exhausted). As noted previously, poor sleep quality may be related to frequent nocturnal disturbances for toileting. Further research is required into the factors involved in frailty progression, and when these factors first impact on frailty elements.

Limitations

The research has a number of limitations. The sample is potentially biased by self-selection. We recruited at least 120 participants in each age category (40-49 years n=140; 50-59 years n=156; 60-69 years n=207;

Table 9. Crude and adjusted associations between PFH and integer predictor variables

		Direction of assocn.	Bladder concerns	Bowel concerns	Bladder bother	Bowel bother
Sleep quality						
	r ²	Positive	3.03%	2.87%	4.45%	3.68%
	F value (p value)		17.92 (p<0.001)	16.95 (p<0.001)	26.69 (p<0.001)	21.19 (p<0.001)
Confounding effect of	Age		4.32 (p=0.001)	1.79 (p=0.07)	3.78 (p=0.001)	2.81 (p=0.005)
	Gender		2.64 (p=0.008)	3.91 (p=0.001)	2.32 (p=0.02)	3.51 (p=0.001)
Adjusted	r ²		7.54%	6.23%	7.79%	7.13%
	F value (p value)		15.52 (p<0.001)	12.73 (p<0.001)	16.32 (p<0.001)	14.78 (p<0.001)
Nutrition						
	r ²	Not clear	0.04%	0.08%	0.06%	0.07%
	F value (p value)		0.32 (p=0.64)	0.15 (p=0.57)	0.44 (p=0.56)	0.55 (p=0.58)
Confounding effect of	Age		4.52 (p=0.001)	1.96 (p=0.06)	3.97 (p=0.008)	2.72 (p=0.008)
	Gender		3.32 (p<0.001)	4.67 (p<0.001)	3.03 (p=0.002)	4.33 (p=0.002)
Adjusted	r ²		4.81%	3.84%	3.95%	3.94%
	F value (p value)		10.92 (p<0.001)	8.74 (p<0.001)	8.23 (p<0.001)	8.93 (p<0.002)
BMI						
	r ²	Positive	3.2%	0.1%	2.2%	0.0%
	F value (p value)		20.93 (p<0.001)	0.91 (p=0.03)	14.61 (p<0.001)	0.03 (p=0.8)
Confounding effect of	Age		3.92 (p=0.001)	1.94 (p=0.06)	3.35 (p=0.001)	2.44 (p=0.01)
	Gender		3.32 (p=0.001)	4.63 (p=0.001)	3.22 (p=0.002)	4.45 (p=0.003)
Adjusted	r ²		7.44%	4.12%	5.63%	4.12%
	F value (p value)		16.94 (p<0.001)	9.13 (p<0.001)	12.63 (p<0.001)	8.94 (p=0.003)
Psychological distress						
	r ²	Not clear	0.52%	0.23%	0.51%	0.32%
	F value (p value)		3.54 (p=0.06)	1.35 (p=0.3)	3.24 (p=0.07)	1.85 (p=0.18)
Confounding effect of	Age		3.64 (p=0.003)	1.87 (p=0.07)	3.12 (p=0.002)	2.52 (p=0.01)
	Gender		3.03 (p=0.003)	4.52 (p=0.001)	3.18 (p=0.002)	2.54 (p=0.01)
Adjusted	r ²		4.02%	3.87%	3.26%	3.94%
	F value (p value)		8.92 (p<0.001)	8.53 (p<0.001)	6.92 (p=0.001)	8.77 (p=0.001)

Table 10. PFH measures and categorical predictor variables

	n	Bladder concerns Mean (SD)	Bowel concerns Mean (SD)	Bladder bother Mean (SD)	Bowel bother Mean (SD)
Smoking	25	1.33 (1.46)	0.44 (0.62)	3.45 (4.32)	0.98 (1.94)
Non-smoker	624	1.54 (1.76)	0.67 (0.71)	4.35 (6.13)	1.96 (2.89)
Health concerns	439	1.53 (1.44)	0.44 (0.72)	3.92 (4.78)	1.13 (2.13)
No health concerns	247	1.14 (1.23)	0.66 (0.67)	2.57 (3.45)	0.87 (1.73)
No alcohol	187	1.44 (1.56)	0.45 (0.75)	3.32 (4.57)	1.23 (2.17)
<10 drinks/week	362	1.43 (1.45)	0.42 (0.68)	3.53 (4.38)	1.03 (1.94)
10+ drinks/week	102	1.12 (1.36)	0.33 (0.67)	3.13 (4.59)	0.85 (1.93)
No medication	217	1.15 (1.34)	0.37 (0.66)	2.78 (3.77)	0.75 (1.62)
1-4 medications	423	1.52 (1.52)	0.53 (0.73)	3.86 (4.71)	1.24 (2.13)
5+ medications	11	1.01 (1.05)	0.12 (0.37)	2.23 (2.73)	0.24 (0.65)
Adequate hydration	330	1.31 (1.46)	0.47 (0.78)	3.44 (4.26)	1.15 (2.03)
Inadequate hydration	320	1.36 (1.43)	0.44 (0.65)	3.57 (4.63)	0.98 (1.94)

70+ years n=153), and thus the study was adequately powered. However, the sample may include people who believed that they had health problems and wanted evidence of such, as well as people who wanted evidence that they did not have health problems and were well for their age. There were very few participants with three or more elements of frailty, and thus frailty was considered in analysis as the presence of one or more frailty elements. Our analyses were thus largely driven by the number of people classified as 'pre-frail'. The small number of frail participants is not surprising, given that our sample was younger than the samples on which frailty research has been conducted in the past^{16,18-20}. Given the opportunistic recruitment in our study, types 1 and 2 errors may well have influenced the significance of comparisons. The impact on the generalisability of the findings from this sample is perhaps evident in the significantly protective odds of frailty for progressively older women compared to those aged 40-49 years. It may be that the older women who participated in our study were healthier than their counterparts in the general population.

The cross-sectional design of this study precluded consideration of causality. There were sound *a priori* reasons to propose that poor PFH was an exposure for frailty^{3,4}; however, the directionality of impact, and the causal role of putative predictors, could not be determined in this study design. For instance, poor PFH, high BMI or taking regular medications may impact on sleep quality, which may in turn be a more proximal exposure for frailty than bladder health as it may have influenced frailty elements such as exhaustion. High BMI may be independently associated with frailty elements such as slow walking speed, poor regular exercise or weak grip strength, and therefore BMI may not act on frailty through poor PFH exposure.

The non-normal distribution of the PFH measures potentially affected the estimation of associations with predictor variables³⁹. Summing the scores for pelvic floor concerns assumed that each concern was of the same importance. The PFH bother measures were re-scaled such that people who reported a concern (1), but were not bothered by it (scored 0), could be differentiated from those people who reported no concern (0) (and therefore had no bother (0)). The equal interval assumptions around the 'bother' scaling ('not-at all' to 'a lot') assumed linearly-escalating bother; however, this may not be an appropriate interpretation. More research is required to determine the magnitude of the steps between the subsequent bother categories, as well as the real impact on daily living, of poor PFH.

CONCLUSION

This community-dwelling sample was mostly younger than that used in frailty research. It demonstrated consistent prevalence of pelvic floor concerns and pre-frailty. The significant associations between PFH, frailty, sleep quality and BMI suggests that early interventions to improve PFH could optimise health more broadly and healthy ageing.

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