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Original Article

Associations of Frailty, Concerns About Falling, and Fall Risk in Community-Dwelling Older Adults in Orlando, Florida: A Preliminary Analysis

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Abstract

Objectives: This study examines relationships between frailty, concerns about falling (CaF), and fall risk in community-dwelling older adults (≥60 years old). **Methods**: Frailty, CaF, and fall risk were cross-sectionally assessed using the FRAIL, short FES-I, and STEADI questionnaires in 178 participants. Spearman correlations, logistical regression, and ordinal regression analysis were performed. **Results**: 38.2% of participants were robust, 48.9% pre-frail, and 12.9% frail. Logistic regressions revealed that frail individuals were 91.4% more likely to have CaF compared to non-frail individuals, and individuals with lower fall risk were 5.7 times less likely to have CaF than those with no fall risk. Pre-frail individuals were more likely to have fall risk than non-frail individuals. Individuals with low CaF were 6 times less likely to have fall risk than those with high CaF. Ordinal logistic regressions revealed that for individuals with no CaF and no fall risk, the odds of being frail were 69.5% and 86.7% lower, respectively, than those with high CaF and high fall risk. **Conclusions**: Frailty relationships with fall risk and CaF indicate the importance of addressing frailty to aid in fall prevention in older adults. Further, addressing the CaF mentality is important in fall prevention in older adults. ClinicalTrials.gov ID: NCT05778604

Keywords: Community, Concerns about falling, Fall risk, Frailty, Older adults

Introduction

Each year, more than one in four older adults aged 65 or older experience a fall and having fallen once increases a person's chance of falling again. Around 3 million emergency department visits are due to falls among older adults yearly[1]. Frailty is a biological syndrome resulting in decreased reserve and resistance to stressors. Frailty results from the cumulative effect of multiple physiological systems declining and increasing a person's vulnerability to adverse outcomes[2]. The prevalence of frailty varies depending on the assessment tools and the population studied, but studies report anywhere from 9 to 15 percent of older adults in the United States are frail, while 44 to 45 percent of older adults in the United States are pre-frail[3,4].

The relationship between frailty and fall risk has been studied, and many investigators identify frailty as a fall risk factor[5-9]. A meta-analysis that included studies from different

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continents concluded that frail men were 1.94 times more likely to fall compared to non-frail men, and frail women were 1.44 times more likely to fall compared to non-frail women[7]. Further, frail older adults in North America were 1.29 times more likely to fall than non-frail older adults[7]. Comparisons of the different stages of frailty show that the odds of falling are higher in frail older adults than pre-frail older adults, but those with pre-frail status are still at a higher risk of falling than non-frail older adults[5,6].

Concerns about falling (CaF) has been identified as a risk factor for fall occurrence, and many community-dwelling older adults report being afraid of falling[10-12]. Individuals with a fall history have a higher report of CaF (96.7%) than those without a fall history (75.1%)[12]. Additionally, a one-year follow-up study with community-dwelling older adults in a Japanese community found that non-fallers, single-fallers, and multiple-fallers with a CaF all reported higher fall rates compared to those without CaF[10]. General characteristics that are shown to have a significant association with CaF include being older than 75 years of age, being female, having a lower level of education, living without a spouse, and having an abnormal body mass index (BMI)[13]. Individuals with higher CaF also have a significantly increased risk of mortality compared to non-CaF participants[14]. Studies also show a relationship between CaF and frailty, where the odds of being frail are higher in those with a CaF[15]. However, there are limited studies focusing on frailty, CaF and fall risk in community-dwelling older adults[16], especially those living in low-income settings in the United States, though it is important to note that studies in developing countries have analyzed the relationships between these factors[17-19].

The objective of the current cross-sectional. preliminary analysis was to illustrate the relationships between frailty, CaF, and fall risk, as determined by questionnaires in low-income, community-dwelling older adults. We further aimed to determine the relationship of these measures with distinct aspects of the fall risk questionnaire. Finally, we aimed to use logistical regression and ordinal regression analysis to describe these relationships.

Methods and Materials

Research Design

This cross-sectional study is part of an ongoing cluster randomized controlled trial study (NIH Grant # RO1MD018025) to test the effectiveness of a physio-feedback exercise program that utilizes wearable technology-based physio-feedback, cognitive reframing, and peer-led exercises for reducing fall risk in low-income, community-dwelling older adults[20]. Community-dwelling older adults 60 years of age or older living in low-income settings in Orlando, Florida, USA were recruited. Low-income status was identified using poverty thresholds for 2019 by family size and number of children age <18, published by the US Census Bureau[21]. Of the 187 participants, 178 participants were included in the current analysis (any participant with missing information was excluded from analysis).

Measures

Frailty

Frailty status was assessed using the simple Fatigue, Resistance, Ambulation, Illness, and Loss of weight (FRAIL) questionnaire which consists of 5 items: Fatigue, Resistance, Ambulation, Illness, and Loss of weight[22]. Participants who reported experiencing fatigue most or all the time received 1 point, while those reporting some, little, or no fatigue scored a 0 for fatigue. Those who reported difficulty walking up 10 steps without resting scored 1 point. Reporting difficulty walking several hundred yards without aids also scored 1 point. Participants with 5 or more chronic illnesses (hypertension, diabetes, cancer, chronic lung disease, heart attack, congestive heart failure, angina, asthma, arthritis, stroke, kidney disease) scored 1 point. Finally, a weight change of >5% in the past year scored 1 point. A score of 0 classified the participant as non-frail, 1-2 as pre-frail, and 3 or more as frail[22]. The simple FRAIL questionnaire has been used in various communities to predict frailty in older adults[22-25].

Fall Risk

The Stopping Elderly Accidents, Deaths, and Injuries (STEADI) checklist from the Center for Disease Control (CDC) STEADI toolkit was utilized for assessing fall risk[26,27]. Participants were asked 12 questions regarding the leading risk factors of falls. Answers of "Yes" for the first 2 questions (haven fallen in the past year and having been advised to use a cane or walker to get around safely) scored 2 points each, and the remaining 10 questions scored a "Yes" answer with 1 point each. An answer of "No" scored 0 points. A score of ≥4-14 indicated that the participant was at risk for falling, and the higher the score, the greater the risk of falling[26]. Previous work demonstrated that the STEADI toolkit had a better predictive validity of discriminating fallers and predicting a future fall when used in community-dwelling older adults than in facility-dwelling older adults[28,29].

Concerns About Falling (CaF)

Concerns about falling (CaF) was measured using the short Fall Efficacy Scale International (short FES-I) questionnaire, which consists of 7 questions scored on a Likert scale ranging from 1 (not at all concerned) to 4 (very concerned). The short FES-I provides insight into a participant's level of concern about falling in a variety of daily living activities[30]. The final score ranges from 7-28 where a score of 7-10 classifies no concern for falling, and a score of 11-28 represents a high concern for falling[30]. The short FES-I has been validated in community-dwelling older adults[30-32].

Power Analysis and Sample Size Justification

We conducted a post-hoc power analysis based on the logistic regression models that were performed. The

Age years (SD)	
Years ± SD	77.1 ± 6.44
Sex n (%)	
Male	18 (10.1)
Female	160 (89.9)
BMI n (%)	
Below normal weight (<18.5)	4 (2.25)
Normal weight (18.5-25)	39 (21.9)
Overweight (25-30)	50 (28.1)
Class I Obesity (30-35)	46 (25.8)
Class II Obesity (35-40)	16 (9.00)
Class III Obesity (>40)	22 (12.4)
Did not complete	1 (0.56)
Place of Birth n (%)	
USA	119 (66.9)
South America	19 (10.7)
Caribbean	12 (6.74)
Asia	10 (5.62)
North America	9 (5.06)
Europe	4 (2.25)
Africa	2 (1.12)
No response	3 (1.69)
Race/Ethnicity n (%)	
African American	80 (44.9)
Hispanic	70 (39.3)
Non-Hispanic White	15 (8.43)
Asian	12 (6.74)
Did not respond	1 (0.56)
Smoking Status n (%)	
Never Smoked	117 (65.7)
Quit smoking at least 10 years prior	40 (22.5)
Current Smoker	11 (6.18)
Quit within the past 10 years	10 (5.62)
Frailty Status n (%)	
Robust	68 (38.2)
Pre-frail	87 (48.9)
Frail	23 (12.9)

Table 1. Descriptive characteristics of participants. Data shown as n-size with percentage in parentheses.

	No Fall Risk	Fall Risk
Non-frail	55	13
Pre-frail	36	51
Frail	0	23

Table 2. Distribution of non-frail, pre-frail, and frail community-dwelling older adults that classified as no fall risk or fall risk. Data shown as n-size.

	No Concerns About Falling	Concerns About Falling
Non-frail	38	30
Pre-frail	28	59
Frail	0	23

Table 3. Distribution of non-frail, pre-frail, and frail community-dwelling older adults that classified as no concerns about falling and fear of falling. Data shown as n-size.

analysis was calculated using G*Power software, with the following parameters derived from the models: a total sample size of 177, an observed effect size in terms of the odds ratio (OR) of 7.590, and a significance level (α) of 0.05. Additionally, the baseline event rate (PO) was set at 0.38, representing the proportion of participants in the reference category, Robust Frailty Status. Based on these inputs, the resulting achieved statistical power was 0.99, indicating that the study had more than sufficient power to detect the observed effect. This high level of power suggests a low likelihood of Type II error, meaning the sample size was adequate to detect a significant association, if one existed.

Statistical Analysis

Normality of the distributions of major scores were tested through D'Agostion & Pearson, Anderson-Darling, Shapiro-Wilk, and Kolmogorov-Smirnov tests with significance set to $p<0.05$. In this study, none of the variables (FRAIL Score, short FES-I, and STEADI Score) satisfied the assumptions of normality. Consequently, we utilized Spearman correlation analysis with a 95% confidence interval to examine the relationships among these variables. To further investigate these relationships, we constructed three logistic regression models: (1) a logistic regression model to predict fall risk versus no fall risk, (2) a logistic regression model to predict high versus no CaF, and (3) an ordinal logistic regression model to predict robust, pre-frail, and frail categories, using the cut-offs presented in Tables 2 and 3. Each logistic regression model was adjusted for age, gender, height, weight, smoking status, and BMI. All statistical analyses were conducted using GraphPad Prism (San Diego, CA) and R (Version 4.4.1), with the significance level set at $\alpha=0.05$.

	DEPENDENT VARIABLE		
	No Concerns About Falling	**No Fall Risk**	**Frail Category**
Independent Variable	*Logistic Regression* Baseline:[Yes, CaF]	*Logistic Regression* Baseline:[Yes, fall risk]	*Ordinal Logistic Regression* Non-frail < Pre-frail < Frail
Pre-frail	0.536 (0.036, 1.035) p = 0.190	**0.265*** (0.022, 0.508) p = 0.005**	**Non-frail vs. Pre-frail *** *Intercepts* 28.1746 S.E. 0.005 p = 0.000**
Frail	**0.086*** (-0.055, 0.227) p = 0.004**	0.000 (-0.000, 0.000) p = 0.986	**Pre-frail vs. Frail *** *Intercepts* 31.6272 S.E. 0.364 p = 0.000**
No fall risk	**6.702*** (0.343, 13.062) p = 0.0001**		**0.133*** (0.057, 0.310) p = 0.000**
No CaF		**6.833*** (0.080, 13.585) p = 0.0002**	**0.305*** (0.136, 0.682) p = 0.004**
Female	3.058 (-1.074, 7.190) p = 0.105	1.447 (-1.187, 4.080) p = 0.691	1.332 (0.453, 3.918) p = 0.602
Age	0.969 (0.905, 1.034) p = 0.360	**0.880*** (0.813, 0.948) p = 0.002**	0.979 (0.931, 1.030) p = 0.411
Quit smoking at least 10 years prior	1.073 (0.009, 2.138) p = 0.889	1.496 (-0.129, 3.120) p = 0.468	1.048 (0.486, 2.260) p = 0.905
Current smoker	1.288 (-0.819, 3.395) p = 0.762	0.532 (-0.346, 1.410) p = 0.454	0.783 (0.201, 3.047) p = 0.724
Quit within the past 10 years	2.035 (-1.399, 5.468) p = 0.410	0.272 (-0.412, 0.956) p = 0.311	0.890 (0.205, 3.865) p = 0.876
Height (inches)	1.119 (0.490, 1.748) p = 0.696	1.725 (0.263, 3.187) p = 0.208	**1.639*** (1.515, 1.773) p = 0.000**
Weight (pounds)	0.980 (0.883, 1.077) p = 0.691	0.901 (0.760, 1.041) p = 0.190	0.929 (0.902, 0.956) p = 0.000
BMI	1.105 (0.491, 1.720) p = 0.725	(0.190, 2.933) (-0.433, 1.324) p = 0.321	1.566 (1.361, 1.803) p = 0.000
Constant	0.007 (-0.239, 0.252) p = 0.786	0.000 (-0.000, 0.000) p = 0.447	NA
Observations	177	177	176 (1 observation deleted due to missingness)
Akaike inf. Crit.	185.658	157.114	295.467

Table 4. Linear regression and ordinal logistic regression analysis. Data shown as odds ratio (95% confidence interval) and p-value. "*p<0.1; **p<0.05; ***p<0.01.

Results

Descriptive Characteristics

After removing participants with missing relevant data, 178 participants were included in frailty, CaF, and fall risk analysis. The average age of the participants was 77.1 (±6.44) years, and the majority were females (89.9%). The majority of participants were overweight or obese, with only 39% having a BMI considered "normal" weight. Birthplace of the participants included the United States (66.9%), South America (10.7%), Caribbean (6.74%), Asia (5.62%), North America (5.06%), Europe (2.25%), and Africa (1.12%), and race/ethnicity of the participants included African-America (44.9%), Hispanic (39.3%), Non-Hispanic White (8.43%), and Asian (6.74%). Finally, the majority of the participants reported having never smoked (65.7%) or having quit smoking at least 10 years prior (22.5%).

Of the participants included, 68 (38.2%) were considered robust, 87 (48.9%) pre-frail, and 23 (12.9%) frail. All descriptive characteristic data are displayed in Table 1. The participants classified as frail all presented with fall risk and CaF. While the majority of participants considered

pre-frail presented with fall risk (58.6%) and CaF (67.8%), most of the non-frail participants were considered no fall risk (80.9%) (Table 2) and over half reported no CaF (55.9%) (Table 3).

Frailty Associations with Concerns of Falling and Fall Risk

Since normality tests were not passed by FRAIL, STEADI, or short FES-I data, Spearman correlation analysis was used to assess relationships between frailty vs. fall risk and frailty vs. CaF. Moderate to strong[33], significant, positive correlations were found for FRAIL Score vs. STEADI Score ($p<0.0001$, $r=0.6284$, CI:0.5268 to 0.7122) and for FRAIL Score vs. Short FES-I Score ($p<0.0001$, $r=0.5251$, CI: 0.4056 to 0.6269) (Figure 1A-B).

Associations between Concerns of Falling and Fall Risk

Spearman correlation analysis for the relationship between STEADI vs. Short FES-I showed a significant, positive correlation ($p<0.0001$, $r=0.7187$, CI: 0.6364 to 0.7849) (Figure 2A).

Associations between Short FES-I Scores, FRAIL Scores, and Components of the STEADI Questionnaire

Spearman correlation analysis for the STEADI question, "I have fallen in the past year" and Short FES-I Score reveals a positive, moderate, significant association ($p<0.0001$, $r=0.4578$, CI: 0.3289 to 0.5700), where an answer of "No" is a score of 1 and an answer of "Yes" is a score of 2 (Figure 3A). "Balance Confidence" was assessed by combining 2 questions from the STEADI questionnaire: 1) "Sometimes I feel unsteady when I am walking" and 2) I steady myself by holding onto furniture when walking at home." An answer of "No" is a score of 1 and an answer of "Yes" is a score of 2. Significant, moderate, positive correlations were found for Balance Confidence and FRAIL Score ($p<0.0001$, $r=0.5690$, CI: 0.4559 to 0.6640), and Short FES-I Score ($p<0.0001$, $r=0.6778$, CI: 0.5858 to 0.7526) (Figure 3B-C).

Logistic Regression Analysis of Frailty, Concern of Falling, and Fall Risk

Table 4 presents the results for three models: (1) logistic regression predicting no CaF versus high CaF (baseline), (2) logistic regression predicting no Fall Risk versus high Fall Risk (baseline), and (3) ordinal logistic regression on Frailty Category (Non-frail < Pre-frail < Frail). Significant findings from each model are summarized below.

In Model (1), the logistic regression predicting the presence or absence of CaF showed that frail individuals were 91.4% more likely to have CaF compared to non-frail individuals (Odd Ratio (OR) = 0.086 with 95% confidence interval [-0.055, 0.227], $p = 0.004$). This is supported by Table 3, which indicates that no participants were frail with no CaF, while 23 were frail with high CaF. No significance

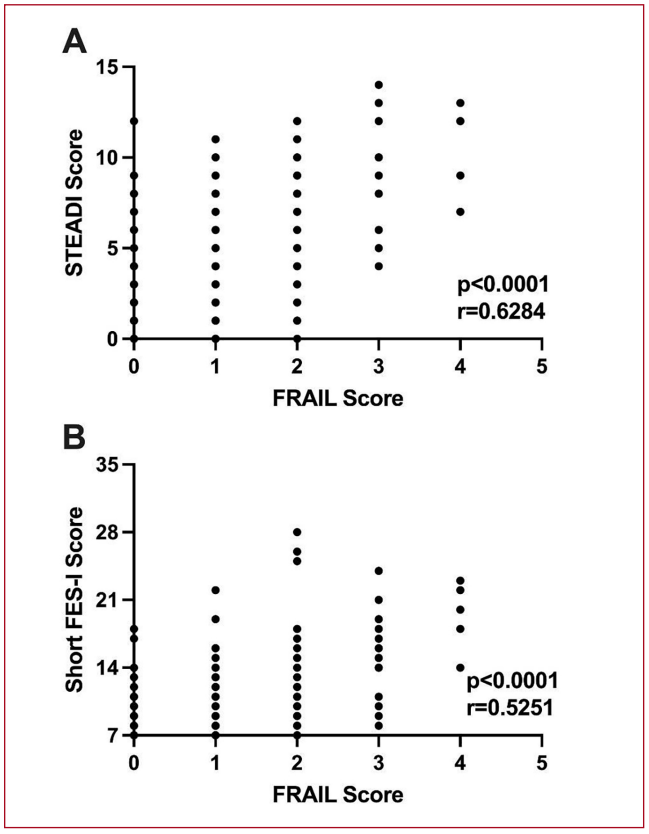

Figure 1. Spearman correlations comparing FRAIL Score vs. STEADI Score (A) and FRAIL Score vs. Short-FES-I Score (B). Significance was set to $p<0.05$. P-values and correlation coefficients (r-values) are displayed in the bottom right-hand corner of each figure.

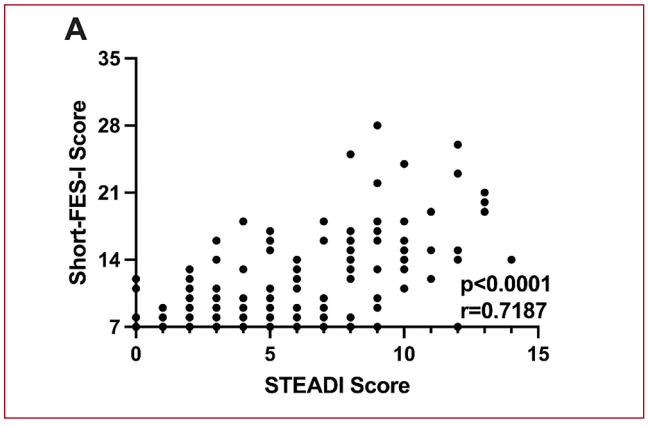

Figure 2. Spearman correlation comparing STEADI Score vs. Short-FES-I Score. Significance was set to $p<0.05$. P-values and correlation coefficients are displayed in the bottom right-hand corner of each figure.

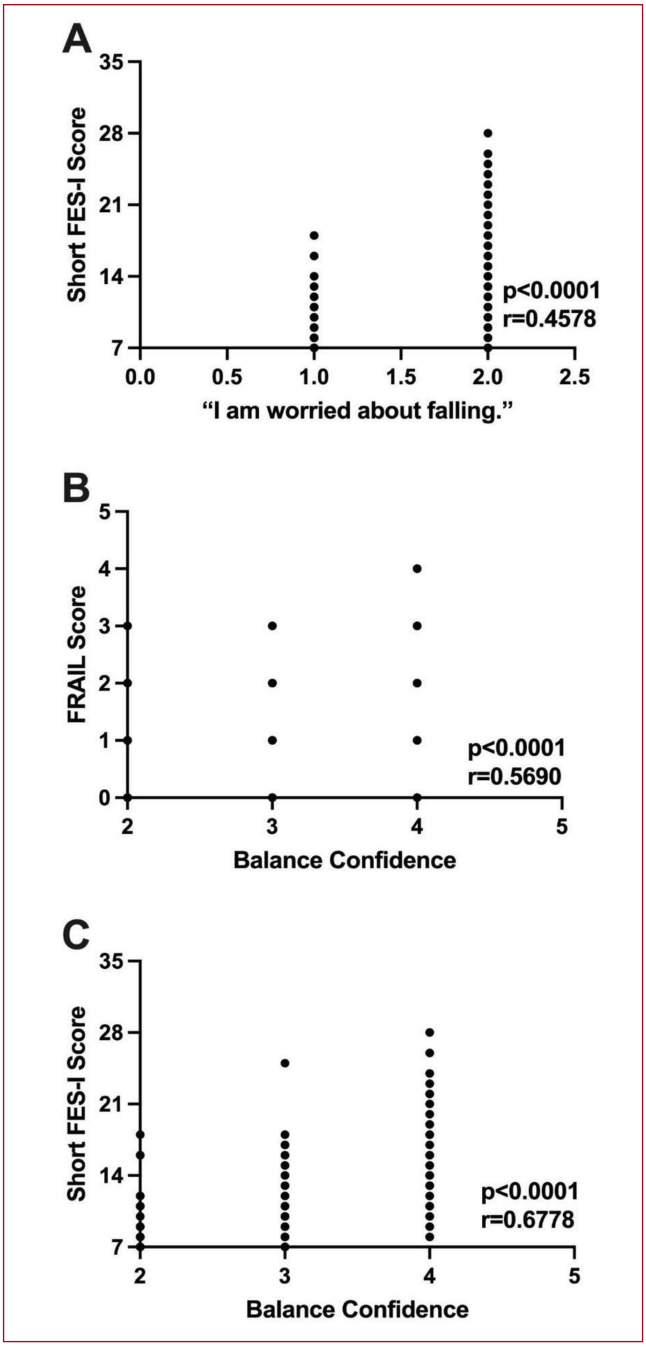

Figure 3. Spearman correlations comparing components of the STEADI questionnaire with FRAIL Score and Short FES-I Score. (A) shows the comparison of the STEADI question, "I am worried about falling" and the Short FES-I Score. (B) shows the comparison of "Balance Confidence" and FRAIL Score, and (C) shows the comparison of "Balance Confidence" and Short FES-I Score. "Balance Confidence" was determined by the combination of the STEADI questions. "Sometimes I feel unsteady when I am walking" and "I steady myself by holding onto furniture when walking at home." For "I am worried about falling," a score of 1 is "No," and a score of 2 is "Yes." For "Balance Confidence," scores range from 2-4, where a "No" for each question is a score of 2, and a "Yes" for each question is a score of 4. Significance was set to $p<0.05$. P-values and correlation coefficients (r-values) are displayed in the bottom right-hand corner of each figure.

was found for CaF between pre-frail and non-frail individuals. Those individuals with lower fall risk were 5.7 times less likely to have CaF than those with no fall risk scores (OR= 6.702 [0.343, 13.062], p=0.0001).

In Model (2), the logistic regression model to predict fall risk (baseline) versus no fall risk revealed that those individuals that were pre-frail were 73.5% more likely to have fall risk than non-frail individuals with OR = 0.265 with 95% confidence interval [0.022, 0.508] and p=0.005, and no significance was found between frail compared to non-frail individuals. Those with low CaF scores were almost 6 times less likely to have fall risk than those that had high CaF (OR = 6.833 [0.080, 13.585], p = 0.0002). Older individuals were 12% more likely to have a fall risk compared to younger individuals (OR = 0.88 [0.813, 0.948], p = 0.002), holding all other predictors constant.

Finally, in Model (3), the ordinal logistic regression analysis showed that for individuals with no CaF, the odds of being frail (i.e., transitioning from non-frail to pre-frail or from pre-frail to frail) are 69.5% lower compared to those with high CaF, holding all other variables constant. This finding aligns with the results presented in Table 3 and Figure 1B. Similarly, for individuals with no fall risk, the odds of being frail (i.e., transitioning from non-frail to pre-frail or from pre-frail to frail) are 86.7% lower compared to those with high fall risk, holding all other variables constant. This is consistent with the results shown in Table 2 and Figure 1A. Moreover, height was also significant, with an OR of 1.639 [1.515, 1.773], p < 0.001, indicating increased odds of being frail.

Discussion

Presently, we aimed to investigate the relationship between frailty, fall risk, and CaF in community-dwelling older adults. We found significant, moderate to strong associations between frailty and fall risk, frailty and CaF, and fall risk and CaF in low-income, community-dwelling older adults residing in Orlando, Florida. Spearman correlation analysis showed significant, positive correlations for these relationships. Further, we dissected the STEADI questionnaire and found a significant, moderate association between "I am worried about falling" and the short FES-I score. We also found significant moderate to strong associations between "Balance Confidence" and the FRAIL and short FES-I scores. While these relationships were mostly moderate, this is a preliminary analysis of an ongoing project. Logistic regression analysis supported these results, including frail individuals being more likely to have CaF, individuals with fall risk being more likely to have CaF, pre-frail individuals being more likely to have fall risk than non-frail individuals, and individuals with no CaF being more likely to have no fall risk than those with high CaF. Furthermore, ordinal logistic regression analysis supported the correlation and logistic regression analysis, showing that individuals with no CaF and those with no fall risk had lower odds of being frail. This

is further supported by Tables 2 and 3, showing that all individuals that classified as frail were also scored as having high CaF and high fall risk.

Various publications have demonstrated a significant relationship between frailty and fall risk exists in older adults, where increased frailty results in an enhanced risk of falling and recurrence of falling[5-8]. Currently, we found a moderate but significant association between FRAIL scores and STEADI scores, suggesting that frail individuals have higher fall risk than non-frail individuals. This was supported by the fact that all individuals classified as frail also classified as having higher fall risk (Table 2). Further, evidence shows differences in fall risk and fall reports in non-frail versus pre-frail and pre-frail versus frail older adults, indicating a gradual increase in fall risk as frailty progresses[4,34-37]. This is supported by a previous study showing pre-frailty and frailty increased risk of future falls, and concerns of falling[16]. Herein, we found that pre-frail individuals were more likely to have fall risk than non-frail individuals. In fact, over half (58.6%) of the older adults classified as pre-frail in the current study had fall risk, while those non-frail community-dwelling older adults mostly reported as no fall risk (80.9%). Further, ordinal logistic regression analysis revealed that individuals with no fall risk were 86.7% less likely to be frail than those with high fall risk scores. This is supported by Table 2 indicating that all older adults classifying as frail also had fall risk according to the STEADI questionnaire score. A previous cross- sectional study in Thailand used a physiological profile assessment (PPA) of fall risk[38] to compare fall risk between non-frail, pre-frail, and frail older adults[8]. This study found that overall PPA of fall risk scores were significantly higher in frail and pre-frail individuals compared to non-frail older adults and that PPA of fall risk was higher in pre-frail compared to non-frail older adults[8]. In fact, frail older adults had reduced visual contrast sensitivity, increased proprioception, decreased knee extension strength, longer hand reaction, and an increased sway path compared to non-frail older adults, while pre-frail individuals had increased proprioception, decreased knee extension strength, and longer hand reaction time compared to non-frail older adults[8]. Finally, linear regression analysis revealed a significant association between frailty status and fall risk[8]. Future work in the current study could compare the relationships between physiological measures like those, frailty status, and fall risk to better elucidate the associations between these measures in community-dwelling older adults. Some publications have indicated no significant difference in fall risk between non-frail and frail older adults[2,39], but this contradiction may be due to the methods of assessing frailty and fall risk and the population being assessed.

There are many factors that have been linked to increased frailty in older adults, including BMI[40,41], physical inactivity[42], sleep quality[43,44], cognitive function[45,46], and concerns about falling (CaF)[16,47-50]. In the present study, we investigated the relationship between frailty status and CaF in low-income older adults in Orlando, Florida. Currently, we have found moderate but significant associations between frailty and CaF in these community-dwelling older adults. Further, logistic regression analysis revealed that frail individuals were 91.4% more likely to have CaF compared to non-frail older adults. This is supported by Table 3 where all older adults classifying as frail had CaF. Past work demonstrated associations between CaF and frailty[47-49], where older adults with frailty reported CaF when performing the following seven daily-life activities: 1) dressing/undressing, 2) bathing/showering, 3) getting in/out of a chair, 4) ascending/descending stairs, 5) reaching overhead for an object, 6) walking up/down a slope, and 7) going to a social event[47,48]. After adjusting for age, hospitalizations in the past year, history of falling in the past six months, and the number of chronic conditions, it was revealed that older adults with a CaF were 7.2 times more likely to be frail[47]. Further, pre-frailty predicted CaF with and without fear-related activity restriction in older adults, while frailty only predicted CaF with fear-related activity restriction in community dwelling older adults[50]. Interestingly, while socioeconomic status has been reported as a risk factor for frailty[51], there are conflicting reports regarding its impact on CaF[52,53]. Socioeconomic status impacts older adults in a variety of ways that could offer potential mechanisms for the current relationship between frailty and CaF in low-income older adults. Reduced health literacy can have an impact on healthy aging and is decreased in low socioeconomic status older adults[54]. Physical inactivity can lead to increased frailty[55], and physical activity levels are negatively associated with CaF scores[56]. Low socioeconomic status is also associated increased instances of disabilities[57], which in turn are linked to poor balance confidence[58] and sedentary behavior[59] in older adults. Future investigations are needed to better understand the role these determinants play in influencing the relationship between frailty and CaF in low-income community-dwelling older adults.

Higher reports of CaF are also associated with falling and fall recurrence[10,11,13,60], and older adults with a history of falling report higher FES-I scores[11,60]. In the current study, a relatively strong association between STEADI and short FES-I found those with higher fall risk also reported higher CaF. This is supported by logistic regression analysis, which revealed that those individuals with lower fall risk were 5.7 times less likely to have CaF than those with high fall risk scores, and individuals with low CaF were 6 times less likely to have fall risk than those with high CaF. The Spearman correlation analysis of the STEADI question "I am worried about falling" and the overall short FES-I score showed a moderate significant association. Various publications demonstrate that CaF is higher in females[11,13,60], and other characteristics have also been reported to have a relationship with CaF including having a lower education level, living without a spouse, being 75 years of age or older, and having an abnormal BMI[13]. Currently, logistic regression showed no differences for CaF with sex, BMI, age, or smoking status.

No differences in sex could be due in part to a majority of the participants (89.9%) being female. It is important to address the CaF in older adults, as this fear is associated with physical activity restrictions and a lower quality of life[60,61].

Finally, we assessed "Balance Confidence" in individuals by focusing on the questions from the STEADI questionnaire that address balance issues. These questions included: 1) "Sometimes I feel unsteady when I am walking," and 2) "I steady myself by holding onto furniture when walking at home." We found that confidence issues (i.e., a higher score) were significantly associated with FRAIL score and CaF scores. In future analysis upon the completion of this project, we will compare measures of static and dynamic balance with this "Balance Confidence" score to determine confidence and physical measures of balance. Balance confidence, measured via the activities-specific Balance Confidence Scale, was identified as the primary predictor of falling in older adults[62], indicating the importance of cognitive perceptions of balance.

This study does present with limitations. This is a cross-sectional analysis, comparing participants who are robust, pre-frail, and frail, and it does not investigate the changes in frailty status for each participant or how those changes affect fall risk and caution of falling. This study also examines CaF as a maladaptive outcome, but it does not address whether the CaF is a realistic reflection of one's actual potential for falling[63]. Future analysis of this work will be needed to compare perceived fall risk and physiological fall risk to determine rational versus irrational perceptions of one's perceived risk of falling. Majority of the participants were female (89.9%). As this study is still ongoing and participants are continuing to be enrolled, the final male sample size is expected to increase by the end of the study next year. Also, this study is a preliminary analysis using baseline assessments. Future publications will be necessary when the project is complete to further understand all aspects of the work, including changes of CaF and fall risk and how they relate to levels of frailty. More longitudinal analysis of frailty status changes and how that relates to changes in fall risk and CaF for each participant will also be relevant to understanding these relationships.

In conclusion, the present work demonstrates intricate relationships between frailty and fall risk, frailty and CaF, and fall risk and CaF in community-dwelling older adults. Spearman correlation, logistical regression, and ordinal logistic regression analysis, along with previous literature, support the relationships between these measures in our older adult population. While this is a preliminary analysis of data from an ongoing research project, analysis of these questionnaires and biometric data will be needed in the future to better understand the relationships between frailty, CaF, and fall risk on a deeper level. This study provides evidence of the importance of screening for early detection of characteristics that increase fall risk, such as frailty and CaF to help prevent future falls. One new research direction we plan to add to the current study is to investigate the relation between participants' frailty and their immune health. Increasing evidence is suggesting that immunosenescence and aging-related inflammation are involved in frailty syndrome[64]. Alzheimer's disease, a condition that leads to cognitive decline and a major risk factor for fall, is closely associated with neuro- and systemic inflammation[65-67]. By incorporating the analysis of immune biomarkers into the screening process using a rapid immunity test[68], it is possible to identify high risk populations early with better accuracy. Falls can result in serious injury, hospitalization, and even death in older adults[69], and reducing fall risk to prevent future falls can help improve the quality of life for low-income, community-dwelling older adults.

Ethics approval

All study procedures were approved by the University of Central Florida Institutional Review Board (IRB #STUDY00003206), and carried out in accordance with the Declaration of Helinski.

Consent to Participate

All participants gave written consent before participating in the study.

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Authors' Contributions

Abigail L. Tice – data collection, data analysis, and manuscript writing/editing. Rui Xie – conception of the research idea, data analysis, and manuscript writing/editing. Wei Zhang – manuscript writing/editing. Norma E. Conner – manuscript writing/editing Yingru Li – manuscript writing/editing. Christopher T. Emrich – manuscript writing/editing. Qun Huo – manuscript writing/editing. Ladda Thiamwong – conception of the research idea, methodology, manuscript writing/editing, supervision, and project administration. All authors read and approved of the final version of the manuscript, and all authors reserve public responsibility for the content.

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