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Behavioural and psychological factors associated with pre-frailty in community-dwelling adults aged 40 and over: a cross-sectional study

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led to a more nuanced understanding of frailty through the identification of its precursor, pre-frailty, a condition where individuals are not yet considered clinically frail but carry a greater risk of progression into clinical frailty than the general population [22]. With an ageing global population, frailty and pre-frailty are increasingly pertinent health concerns. Global estimates suggest approximately 12% of individuals aged over 50 years are frail, with pre-frailty affecting nearly 46% [41]. In Australia, 21% of those aged over 65 are considered frail, and an additional 48% are pre-frail [55]. With projections indicating that the proportion of the Australian population aged over 65 will rise to 18% by 2027, there is an increasing urgency to address frailty and pre-frailty [54].

The increasing recognition of frailty has prompted exploration of physiological and psychological factors beyond the conventional frailty measures that may be associated with, help predict, or influence, the physiological decline associated with frailty. In adults aged over 65, low physical activity, high sedentary behaviour, low quality of life, loneliness, and social isolation are cross sectionally associated with higher levels of pre-frailty and/or frailty [9, 16, 23, 24, 30, 35, 37, 48, 53]. It is important to note that low physical activity is often included as part of the operationalisation of physical frailty, such as in the Fried Phenotype, which may explain its consistent association with frailty in cross-sectional studies. Other factors, such as loneliness and negative attitudes towards ageing, represent broader psychological and social influences that extend beyond the physical components of frailty. Additionally, more positive attitudes towards ageing have been associated with reduced physical frailty levels in adults over 60 years, while negative attitudes towards ageing have been linked with frailty in nursing home residents with an average age of 84 [9, 23].

These findings are particularly relevant in the context of the World Health Organisation's Decade of Healthy Ageing initiative, which highlights the importance of fostering positive attitudes toward ageing as a critical component of promoting healthy ageing and reducing the burden of frailty globally [63]. In addition to these factors, social determinants of health, such as socioeconomic status, education, and access to healthcare, also play a critical role. Research has shown that individuals with lower levels of formal education or lower socioeconomic status are at increased risk of frailty, even at younger ages [8, 52]. These determinants highlight the importance of addressing systemic inequities and integrating social interventions into frailty prevention strategies. It is not yet known if these factors and social determinants, and their relationship to frailty and pre-frailty, extend to a younger, middle-aged cohort.

Recent international studies have shown a notable prevalence of pre-frailty among adults aged 40 to 65 years. Hanlon et al. [26] reported that 38% of adults in the United Kingdom within this age bracket were identified as pre-frail according

to the Fried Phenotype. Similarly, Gordon et al. [25] reported that 30% of Australian women and 43% of men aged between 50 and 59 years were classified as pre-frail using the same criteria. Despite this, the majority of literature on frailty and pre-frailty and contributing factors focuses on older adults, primarily aged 75 years and above [2, 17, 58].

Given the high prevalence of pre-frailty in adults aged 40–65, it is important to identify potentially modifiable contributing factors, providing opportunities to reduce the onset and progression of pre-frailty. Previous research has shown that incorporating behavioural and psychological data into predictive models can significantly improve their accuracy and utility in clinical settings [12, 18, 56]. This is crucial for identifying at-risk individuals and designing comprehensive and multifaceted interventions to inform behaviour change interventions, such as programs aimed at increasing physical activity or improving social engagement [1, 5]. A deeper understanding of these relationships can inform public health policies and community programs aimed at promoting healthy ageing, fostering resilience, and enhancing social support networks among middle-aged adults as well as reducing healthcare costs and improving the quality of life for individuals as they age. Understanding the behavioural and psychological predictors of frailty and pre-frailty will inform interventions to promote healthy and successful ageing [27, 37, 47].

This study aimed to examine associations between physiological and psychological factors, and frailty and pre-frailty in an age diverse cohort of adults aged 40 years and over. Based on the existing literature on older adults, it was hypothesised that in middle-aged adults, frailty and pre-frailty would be associated with lower levels of physical activity, poorer quality of life, higher levels of loneliness and social isolation, negative attitudes towards ageing, and a higher felt age.

Method

Study design

An online cross-sectional survey (surg44395751 371.080596923) was conducted in the United Kingdom (UK) between 2020 and 2021. The study was approved by the local research ethics committee.

The term "frailty" was not specifically emphasised in the advertisements to avoid biasing the sample towards individuals who self-identify with frailty. Instead, the advertisements encouraged broad participation to explore diverse factors influencing health and ageing. To ensure data quality, the survey included an attention check item instructing participants to select a specific response. Participants were eligible if they were aged 40 years or older, could provide informed consent, and had access to an internet-enabled device to complete the survey. Participants who failed the attention check, or did not answer enough of the FRAIL Scale questions to assess frailty, were excluded from the analysis.

Survey instruments

Demographic information

The survey included demographic questions including age, height, weight, sex, living situation, country of residence, and highest level of education.

Physical activity

Physical activity was assessed using the short form International Physical Activity Questionnaire (IPAQ) [15].

Social isolation

Social isolation was measured with the 6-item Lubben Social Network Scale (LSNS-6) [38]. Each item asked participants the frequency of various forms of contact with various social connections (e.g. “How many relatives do you feel close to such that you could call on them for help?”). Responses ranged from 0–5 with 5 indicating more social engagement. Scores range from 1 – 30 with lower scores indicating greater social isolation. The LSNS-6 has previously demonstrated strong reliability and validity in adults aged 60+ [11]. The LSNS-6 does not have published psychometric properties for adults aged 40–60 years, however, internal reliability in the pre

Cross-sectional associations of frailty status and behavioural and psychological factors

There were significant differences between frailty categories for all outcomes except total activity time (IPAQ) (Table 2). Post-hoc analyses revealed that individuals with frailty were significantly more likely than non-frail and pre-frail individuals to feel older than their biological age (non-frail $p=0.002$; pre-frail $p < 0.001$), score lower in mental wellbeing (SF-12 MCS) (non-frail $p < 0.001$), and age (non-frail p

expected. The association with negative attitudes towards ageing highlights the importance of fostering positive perceptions of ageing as a public health priority, aligning with the World Health Organisation's Decade of Healthy Ageing initiative [63]. This initiative highlights the role of positive attitudes in promoting healthy ageing and reducing frailty at a population level. Smaller social networks and higher loneliness levels imply that social factors play a role in the early stages of frailty, emphasising that social integration and mental health are important considerations across the lifespan. The association between feeling older than one's chronological age and pre-frailty suggests that subjective age is an important consideration for future research on frailty.

These findings align with previous research demonstrating the significant influence of psychological and social determinants of health on frailty. For instance, education status (a measure of socioeconomic status) is a strong predictor of frailty in older adults (60

progression. Reliance on self-reported data may also introduce bias, particularly in the assessment of physical activity and health-related behaviours. Second, this was a convenience sample recruited online, which may

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 7 October 2024 Accepted: 14 February 2025

~~Published online: 14 March 2025~~

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