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DOI:
10.1016/j.maturitas.2020.05.010

License:
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Document Version
Publisher's PDF, also known as Version of record

Citation for published version (Harvard):
Majid, Z, Welch, C, Davies, J & Jackson, T 2020, 'Global frailty: the role of ethnicity, migration and socioeconomic factors', *Maturitas*, vol. 139, pp. 33-41. https://doi.org/10.1016/j.maturitas.2020.05.010

Maturitas 139 (2020) 33–41

Contents lists available at ScienceDirect

Maturitas

journal homepage: www.elsevier.com/locate/maturitas

Global frailty: The role of ethnicity, migration and socioeconomic factors

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ARTICLE INFO

Keywords:
Frailty
Global ageing
Migration
Ethnicity

ABSTRACT

Frailty is an important consequence of ageing, whereby frail patients are more likely to face adverse outcomes, such as disability and death. Risk of frailty increases in people with poor biological health, and has been shown in many ethnicities and countries. In economically developed countries, 10% of older adults are living with frailty. Ethnic minorities in the West face significant health inequalities. However, little is known about frailty prevalence and the nature of frailty in different ethnic groups. This has implications for healthcare planning and delivery, especially screening and the development of interventions. Global frailty prevalence is variable: low- to middle-income countries demonstrate higher rates of frailty than high-income countries, but available evidence is low. Little is known about the characteristics of these differences. However, female sex, lower economic status, lower education levels, and multimorbidity are identified risk factors. Ethnic minority migrants in economically developed countries demonstrate higher rates of frailty than white indigenous older people and are more likely to be frail when younger. Similar patterns are also seen in indigenous ethnic minority marginalised groups in economically developed countries such as the US, Australia and New Zealand, who have a higher prevalence of frailty than the majority white population. Frailty trajectories between ethnic minority migrants and white indigenous groups in high-income countries converge in the 'oldest old' age group, with little or no difference in prevalence. Frailty risk can be attenuated in migrants with improvements in integration, citizenship status, and access to healthcare. Ethnicity may play some role in frailty pathways, but, so far, the evidence suggests frailty is a manifestation of lifetime environmental exposure to adversity and risk accumulation.

1. Introduction

Health care systems internationally are facing the challenges associated with ageing populations. Global projections estimate that by 2050, one in six people will be over the age of 65, numbering around 1.5 billion people [1]. In 2018, over 65 year-olds outnumbered children under the age of five globally for the first time [1]. The United Nations (UN) predicts that in Europe by 2020 the number of people over the age of 85 ("the oldest old") will be 40 million, a considerable increase from 14 million in 2012 [2]. This increase in older adults across the world is already impacting on health care delivery, especially in high income countries (HICs, as defined by World Health Organization, WHO, regions and World Bank income categories) where more evidence is available. Ageing populations around the world will likely impact upon developing health services in low income countries, lower-to-middle income countries and upper-middle-income countries (LICs, LMICs, and UMICs as defined by World Health Organization, WHO, regions and World Bank income categories respectively; for the purposes of this review, we have grouped these countries together as LMICs). Understanding the effects of ageing on healthcare are vitally important, and especially so in a global context.

One of the most challenging aspects of ageing is frailty. Frailty is characterised by loss of biological reserve and failure of homeostasis, resulting in increased vulnerability to stressors, for example infection, and increased likelihood of suffering adverse outcomes. For examples, individuals that are frail are more likely to have increased mortality,

Abbreviations: ADL, activities of daily living; BME, black and ethnic minority; CFS, clinical frailty scale; eFI, electronic Frailty Index; FI, Frailty Index; HIC, high-income country; HQOL, Health-related Quality of Life; LMIC, low- to middle-income country; UN, United Nations; WHO, World Health Organisation

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https://doi.org/10.1016/j.maturitas.2020.05.010
Received 28 February 2020; Received in revised form 17 May 2020; Accepted 19 May 2020

longer lengths of hospitalisation, increased disability and dependency, delirium, falls, and higher rates of institutionalisation after periods of illness [3–6]. There is a well recognised theoretical framework for frailty, however, its translation to clinical measures and practice has been controversial. Frailty is described as either a 'frailty phenotype' as defined by Fried [3] or the cumulative deficit model in the form of the Frailty Index, as developed by Rockwood and colleagues [7]. The Fried frailty phenotype is based on five predefined criteria that assess the presence or absence of symptoms [3]. These criteria are: unintentional weight loss (4 kg in past year), self-reported exhaustion, weakness (reduced grip strength), slow walking speed, and low physical activity. These are categorized as: frailty (3 or more), prefrail (1 or 2), and no frailty. The Frailty Index on the other hand is composed of a checklist of clinical conditions. The original version had 70 items, but estimates of risk are robust when 30 to 50 are considered. Its distinctive quality is in its continuous nature, allowing for measures of severity. Increasingly, it is recognised that it is important to consider the frailty phenotype and the Frailty Index not as alternatives, but complementary [8].

Multimorbidity is a key risk factor for developing frailty, and they are also associated with one another. Multimorbidity is defined as the co-occurrence of two or more chronic diseases in the same individual [9]. The literature has previously used the terms frailty and multimorbidity. Although multimorbidity overlaps with frailty, we know the single most important risk factor for developing multimorbidity is ageing; the literature has used the terms interchangeably with each other, and 'disability' in the past. We now know, frailty and multimorbidity are distinct concepts, in both HICs and LMICs [10,11]. In particular, populations in LMICs that demonstrate frailty overlap with multimorbidity, but are not wholly similar. It is thought that multimorbidity likely precedes frailty, and older frail individuals are at higher risk of developing disability [11]. Older adults, therefore, represent a heterogeneous population, with increased prevalence of both frailty and multimorbidity.

In an increasingly globalised world, particularly with challenges of climate change and conflict, migration is an important issue. Health disparities across the world are both persistent and pervasive [12]. Economically developed countries, primarily in the West, have faced unprecedented levels of migration in the 20th and 21st century, resulting in many countries now having ethnically diverse populations. Unfortunately, health disparities amongst ethnic minority groups in the West are well recognised. We see this in both life expectancy, and other healthcare outcomes. This is predominantly due to poverty, and poorer socioeconomic status. Many migrant groups that make up ethnic minorities in HICs are socioeconomically disadvantaged. It has often been argued that lower socioeconomic status is directly affected by the process of migration itself. Even after adjusting for educational level, and the change in socioeconomic status (including migration generation), as well as other socioeconomic factors, ethnic minorities face poorer health outcomes. These populations are inherently vulnerable, and have heightened stress-induced disease burdens due to virtue of being of ethnic minority background [13]. Some of this healthcare disparity can also be partially related to inequalities in healthcare provision. Data persistently show both access and quality of care received by ethnic minorities is poor [12], and this is exacerbated in older age [14]. In the UK, those from black and ethnic minority (BME) groups have poorer health than their Caucasian British counterparts [15,16]. BME communities face other inequalities in general; lower socioeconomic status, deprivation, and poorer income. However, poorer health outcomes persist even after controlling for social disadvantage covariates, BME individuals report worse healthcare experience. Individuals born in Pakistan and Bangladesh, particularly women below 75 years-old, have significantly higher rates of cardiovascular disease mortality compared to the indigenous population in England [17]. Diabetes Mellitus affects those of South Asian heritage disproportionately compared to White Europeans living in the UK, up to six times higher risk [18]. Inequalities persist in later life, with Pakistani and Bangladeshi older people particularly vulnerable to poorer health [15].

There are ethical and financial implications for addressing health inequalities, both for outcomes and healthcare access. All people, including older adults, are deserving of respectful and culturally sensitive healthcare. Importantly, medicine should be based on the best quality evidence that is scientifically robust for them. With increasingly diverse populations, it is important to address ethnic minority healthcare inequalities. A clearer understanding of frailty development, trajectory, drivers, and consequences are vitally important to inform and prioritise health care delivery and importantly, intervention. It is unclear whether health disparities in ethnic populations are down to genetic differences, because of ethnicity or non-genetic differences that are environmental. Health disparities may be affected by being an ethnic minority, such as: cultural lifestyle differences, poorer access to good healthcare, socioeconomic status, and discrimination. Disparities in frailty may be due to a combination of these, or it may be that how we measure frailty in ethnic minorities is inherently inaccurate. How frailty manifests, between different ageing ethnic groups is unknown. One of the models to research ethnicity in frailty is migration; comparing frailty prevalence in migrant groups in HICs to their counterparts in home countries provides a natural model to tease out the effects of ethnicity and genetics.

The purpose of this review is two-fold. Firstly, it is to collate the existing evidence of how frailty prevalence differs globally. The second aim is to assess the evidence of frailty prevalence, and where possible, frailty characteristics, in older people that have migrated from LMICs to HICs compared with the indigenous population in HICs. This is to ultimately assess the impacts of ethnicity, genetics and migration on frailty development, and identify gaps in our understanding of frailty between different groups of people. There is a relative paucity of research into ageing in general, and especially frailty in the developing world, and very little in migrant and/or ethnic minorities in HICs.

2. Global frailty

The question of whether frailty differs in different ethnic groups is a difficult one. The best model used to look at this has been to look at frailty in different indigenous groups. Although 'country' does not define ethnicity nor race, it is a good proxy to look at these differences. There has been considerable epidemiological work done on frailty in high income countries. Less research has been done in LMICs with very little longitudinal data.

2.1. A global overview

A systematic review of frailty in community-dwelling older people reported mean weighted frailty prevalence at 10.7% [19]. This number is widely considered to be the standard against which other studies measure their frailty prevalence. However, all studies included were completed in HICs. Two of the largest multi-country data sets are the Study on Health, Ageing, and Retirement in Europe (SHARE), which includes European countries only, and the World Health Organisation (WHO) Study on global AGEing and adult health (SAGE). SAGE collected data from 14 HICs in Europe, and 6 LMICs. Both SAGE and SHARE used the deficit accumulation model (in other words, frailty index) in their frailty assessments. In SHARE, European countries in Southern and Eastern Europe had the highest frailty index scores, with the lowest frailty found in Western and Northern Europe [20]. SAGE showed that Russia had the highest mean frailty index, and, China, an upper-middle income country (for the purposes of our review, an LMIC) had the lowest mean frailty index. Both studies show that frailty increases with age across all populations, with higher rates of frailty amongst women. Frailty was also inversely related to both education and income; less educated, lower income individuals were more likely to exhibit greater frailty. These patterns were consistent in LMICs and

HICs. SHARE countries are much wealthier and likely more homogenous compared to countries in SAGE, and, therefore, higher frailty scores seen in SHARE countries may be due a survivor bias [20]. It should be considered that these differences may be down to measurement bias; the frailty index was initially validated in Canada, and its application may not be valid in other countries, particularly LMICs [21].

Frailty prevalence has previously been shown to be higher in adults in upper-middle income countries and LMICs compared to HICs [22]. Seven studies in China, demonstrated the lowest pooled frailty prevalence at 3.9%, and three studies in Cuba showed the highest at 51.4%. The pooled frailty prevalence of community–dwelling older adults across all studies reviewed by Siriwardhana et al., was 17.4% – higher than in any HIC. Similar patterns were found in a review of frailty in 'developing' countries [23]; overall, LMICs (except China) had higher rates of frailty than HICs.

Frailty in LMICs predicts dependence and mortality. The population cohort 10/66 Dementia Research Group study [24] examined frailty in Latin America, India, and China. Pooled frailty prevalence was 17.5%, which rose to 29.1% using a multidimensional frailty criterion, akin to a frailty index. The highest prevalence of frailty was in the Dominican Republic, and the lowest in urban China. In all countries looked at, frailty was associated with onset of dependence and mortality, even after adjusting for chronic diseases and baseline disability scores. Using both a physical frailty measure and a multidimensional model had predictive value for dependence and mortality.

2.2. Latin and South America & the Caribbean

Countries in Latin and South America and the Caribbean (LAC) are similarly experiencing rapid growth of an ageing population. Latin American adults have higher rates of chronic disease and disability as they age compared to counterparts in HICs. 29 studies from LAC countries with 43, 083 individuals reported frailty prevalence in community-dwelling older adults at 19.6% (range 7.7% and 42.6%) [25]. Frailty is higher in Central America compared with South America, however, it should be noted that the high levels of heterogeneity between studies making it difficult to interpret results with certainty.

2.3. Africa

Similarly, despite being one of the world's poorest and youngest regions, Africa, especially sub-Saharan Africa, is experiencing exponential growth in its ageing populations [26]. This is due to advances in Human Immunodeficiency Virus (HIV) therapies improvement in childhood mortality rates, and economic growth. A cross-sectional study of ageing in rural South Africa, the Health and Aging in Africa: A Longitudinal Study of an INDEPTH Community in South Africa (HAALSI) surveyed over 5000 participants using a phenotype model. Depending on how frailty phenotype components were measured ('frailty score variants'), frailty prevalence was between 3% and 9.6%. Frailty prevalence increased with age. Above age 70, more women were frail than men, with rates rising more steeply with age [10]. Prevalence of disability increased alongside frailty, and those who were frail had worse adverse health and functional outcomes than those considered 'non-frail'. Frailty was a strong mortality predictor. HAALSI adds to other African studies [27] that report higher rates of frailty in Africa than those reported in HICs, and arguably at similar levels to Latin America.

It is important to note the scarcity of data from African communities. South Africa is quite atypical of most sub-Saharan Africa given the improvement in life expectancy from HIV prevention and treatment programmes; understanding frailty in a sub-Saharan African population is vitally important. With older adults in the region already outnumbering all older adults in Europe [28], the impacts of ageing, and understanding and planning for frailty are essential. The importance of older adults in Africa is not to be underplayed, with them often playing crucial roles – for example, caring for grandchildren and other non-biological children [28]. Failing health of older adults means caring responsibilities often fall on female younger family members whose own health and education opportunities are affected, both of which we know impact on future adult health outcomes, including frailty. We also know that older Africans are the least likely to make use of healthcare services [28], despite having the poorest outcomes.

2.4. Asia

Much of the literature on frailty in Asia is based in HICs, such as Japan and Taiwan. Cohort data from LMICs is especially low in these areas. Japan has one of the highest life expectancies, and, therefore, has a more rapidly ageing population [29]. A recent meta-analysis [30] assessing frailty prevalence using the phenotype model, found frailty ranged between 4.6% and 9.5%, with a pooled prevalence of frailty at 7.4%. Prevalence increased with age and in women. Unique to Japan is the narrower range in frailty prevalence (of confidence interval) compared to other countries [30], where frailty seems to be confined to the 'oldest old' and overall frailty prevalence is low. This suggests a strong survivor effect seen in the Japanese compared to non-Japanese populations.

Similar to Japan, Taiwan also has low rates of frailty; a cohort study of older Taiwanese older adults put frailty prevalence at 4.86% [31]. Overall, frailty increased with age, but the highest frailty prevalence was in the 75–79 years age group, and women had higher frailty prevalence after age matching. Increased frailty prevalence was associated with and low education attainment and illiteracy. Multi-morbidity was also significantly associated with increasing frailty; association with disability was less concordant. The prevalence figures in Taiwan are comparatively similar to the very low prevalence rates of frailty found in China as reported earlier; geographical proximity or genetics may be of relevance [22,24]. Small studies in Malaysia show high frailty prevalence at 18.3% [32]; higher than previously reported local data [33,34].

Despite the aforementioned systematic review of frailty prevalence in LMICs [20,22], very few include South Asian countries. SAGE suggested that India has relatively high rates of frailty prevalence. A cross-sectional study in a community-dwelling rural population in Sri Lanka found the prevalence of frailty to be at 15.2% [35]. As expected, frailty prevalence increased with age (over half of over 80 year-olds were frail), and women were at higher risk of frailty. Frailty prevalence was higher in Sri Lanka across all older (over 65 years) age groups compared to similar income countries and upper middle-income Asian countries such as China and Malaysia. A small study in Pune, India showed frailty prevalence at 26% using a phenotypic definition [36]; in a study in Nepal frailty prevalence was at 27.7% using the Clinical Frailty Scale (CFS) [37]; and Thailand 65.2% using a phenotypic definition [38]. It is difficult to draw conclusions with certainty given the diversity in frailty measurements, except to say that it is likely frailty prevalence is higher than HICs in these countries.

The number of older adults in Pakistan was 7.3 million in 1998; this has rapidly increased to 20 million [39]. Reportedly, over 40% of households have an older person living in them [40]. Life expectancy has increased to 69 years in the last 50 years, but the expectancy of 'healthy life' is still relatively low at 54.2 years for men and 52.3 years for women [41]. Once Pakistanis reach the age of 60, they are expected to have 11.4 years disability-free [41]. Considering associations of disability and frailty, this suggests the onset of frailty at a younger age. No studies have specifically examined prevalence of frailty in older Pakistanis, but some work has looked at multimorbidity.

2.5. The USA model

North America provides a unique environment to study the

differences in ethnicity, health, and frailty. Both White Americans and Black African-Americans can be considered migrant populations, with considerable different lived experiences over time and extremely different psychosocial environments (for example, slavery). More recent history of migration to the United States of America (USA), akin to migration patterns in Europe, includes the Hispanic community from Latin and South America, and migrants from the Far East, such as Vietnam, and the Philippines.

The Healthy Aging in Neighbourhoods of Diversity across the Life Span study (HANDLs) was based in a middle-aged population in Baltimore. It explored impacts of race and socioeconomic status, which are intimately intertwined in the USA [42], on frailty. Black African-American and White American participants were matched and compared. In the whole cohort, cross-sectional assessment found 11% of participants were frail, using a modified 'FRAIL Scale', or Clinical Frailty Scale (CFS). Frailty prevalence increased with age in both populations. However, in the oldest (55–64 years) cohort of patients, there was no difference in frailty between Black African-Americans and White Americans. Race was associated with frailty in the younger (45–54 years) cohort; unexpectedly, after adjusting for poverty, the white population was frailer. Overall, in those under the age of 55, white participants had higher odds of being frail compared to black African Americans (OR = 1.84; 95%CI 1.30–2.60). Living in poverty, high Body Mass Index, and being female were all associated with increased rates of frailty [43].

These findings from HANDLs are converse to those demonstrated by the Cardiovascular Health Study (CHS), which was pioneering in developing the Fried phenotype as a frailty assessment model, and included older participants than HANDLs. CHS also examined frailty between different ethnic subgroups [44]. Black African-Americans had two-fold higher rates of frailty compared to White Americans, after adjusting for health and socioeconomic status. They also had higher prevalence of frailty in all age groups, but racial disparity was most pronounced in the younger cohorts (65–74 year olds). Both groups demonstrated increasing prevalence with age, but this excess prevalence in Black African Americans actually declined after the age of 74 years. White participants who were frail had a higher prevalence of disability compared to frail Black African Americans [44]. CHS findings suggest that there are ethnicity-dependent disparities, independent of gender, age, and, socioeconomic status, and that genetics may affect the penetration of frailty as a phenotype. It is important to note comparing the results from HANDLs and CHS may be problematic. HANDLs overall had a smaller cohort compared to CHS (just under 2500 participants versus over 5000 participants), with a much younger population than traditionally looked at in ageing research. In addition, HANDLs used a CFS whereas CHS was used to develop the Fried phenotype. It is therefore important to understand that the limitations of these data contextualise the drivers of frailty in Black African Americans being less clear, and the correlation with ethnicity is not completely straightforward.

Older Mexican Americans also exhibit high rates of frailty, between 20 and 36% [45]. Disability rates are almost as high as that of Black-African Americans [46]. There may be differences in frailty between at least White and Black migrants to the USA [44]. Many Mexican communities could be considered Native Americans, given their ancestral roots in Southern USA states (e.g. Texas). However, large swathes of Latin American communities have also been affected by slavery and colonisation resulting in genetic heterogeneity. Higher rates of frailty in Mexican American migrants are consistent with high rates seen in native Mexicans in the SAGE cohort [20]. This may suggest some role of ethnicity. Further research is needed to determine how the process of migrating to a HIC alters the frailty trajectory in these communities, who generally remain poorer, still have poorer access to good healthcare, and have higher rates of multimorbidity.

Having considered migrants in the USA, those native to North America are an important ethnic group to consider. There is a paucity of ageing research in Native Americans. Overall, older Native Americans have low rates of frailty at 2.9%, but younger Native Americans have been shown to be more likely to be frail [47]. This may suggest a selective survivor effect in this cohort. Women were, again, more likely to be frail. Similar to other race and ethnic minority studies, increased age and lower educational levels were significant correlates with frailty. Multimorbidity has also been shown to correlate with frailty in Native American older adults.

2.6. Indigenous ethnic minorities in HICs

The USA is not the only HIC country that demonstrates unique migration and ethnicity patterns. As we have addressed frailty in Native Americans, it is pertinent that we address the unique status of indigenous ethnic minorities in other HICs, such as Australia and New Zealand. With predominantly European migration to these countries over the last few centuries, the indigenous populations of these countries are now ethnic minorities, and also marginalised groups. There is a considerable paucity of ageing research in these groups. In Australia, indigenous aboriginal Australians make up 3% of the population [48] and experience considerable health inequality; discrepancies exist in life expectancy, chronic disease, mental health and disability compared to white Australians [49]. It is not unexpected therefore that aboriginal Australians also demonstrate high rates of frailty compared to white Australians, and at a younger age. In one study of aboriginal Australians over the age of 45, frailty prevalence in 45–49 year olds was 54.9%, and this increased with age, being higher than white Australians in each age group [48]. Over 80 year olds demonstrate frailty prevalence of 83.3%. Similarly, the indigenous Maori of New Zealand, also an ethnic minority and marginalised group, demonstrate higher rates of frailty prevalence (11.5%) compared to non-Maori white New Zealanders (7.9%) [50]. This also happens at younger ages, with Maori experiencing higher rate of frailty incidence up to 15 years earlier [50]. However, it is likely a higher proportion of Maori live beyond their mid- 70 s with more relative number of co-morbidities.

What these data show is that frailty prevalence across the globe is not consistent even in the same country; and although useful, simple economic categorisation such as LMIC and HIC do not express the nuance and complexities of race, and the inextricably linked socioeconomic factors.

2.7. Global frailty and longitudinal data

Longitudinal studies allow a richer exploration of drivers of frailty than cross sectional studies. Few studies have assessed birth cohort effects on frailty; these have drawn conflicted conclusions [51–53]. In China and Hong Kong [54], cross-sectional assessments of frailty prevalence done in 4 cohorts of older adults across the 20th century found that more recent cohorts (adults born towards the middle half of the 20th century) have been shown to have higher levels of frailty than historical cohorts (those born in the first half of the 20th century). This effect remains after adjusting for demographics, socioeconomic status, social factors, and lifestyle. Higher levels of education, working, and regular exercise were all associated with lower frailty index scores. Similar frailty longitudinal trajectories have been demonstrated in the UK [52] and USA [51] with higher rates of frailty in recent cohorts compared to historical cohorts. The opposite has been found in a study in Sweden where it is thought improved physical functioning and physical activity that has been reported as frailty indicator in younger cohorts may account for this. It is important to note this study only used three criteria from Fried for their frailty assessments. There was a clear association with educational levels and improvement in frailty, especially amongst women – those of lowest educational attainment were least likely to have improved in frailty prevalence. There may be survivor effects; people born in the earlier part of the century are more likely to have died. There is likely to be survivor bias in European

countries in particular, as healthcare systems are well-funded, well-staffed, and easily accessible, however this remains inconsistent in the literature. As discussed, access to healthcare is part of migrant acculturation. This may impact upon migrant cohorts early, but longitudinal data is needed to demonstrate causal effects.

Older Mexican Americans were studied in the Hispanic Established Populations Epidemiologic Studies of the Elderly study over a 12 year period [55]. In this study, participants were classified as developing frailty in three ways: low, progressively moderate, and progressively high frailty. The number of participants who were 'not frail' reduced over time. The effects of stressors and social support on frailty were explored; the effect of accumulating stressors and social support varied according to a person's frailty trajectory. A high number of health stressors were found to increase frailty over time, and in those who continued to become progressively frailer. Interestingly, participants on the progressively moderate frailty trajectory were protected against increases in frailty with improved social support, and also demonstrated the most potential to change. This suggests that this group of people may be a 'transition' group that could be targeted for frailty interventions. Even in one ethnic group, frailty does not behave in a homogenous manner. There are very few studies looking at frailty trajectories in ethnic minorities, and the fact we start to see differences even in one or two studies is evidence that more longitudinal studies are needed.

2.8. Conclusions on global frailty

There are differences in frailty prevalence around the world; LMICs (with the exception of China) in general demonstrate higher frailty rates than HICs as demonstrated in Fig. 1. In addition, higher frailty prevalence is associated with higher rates of adverse outcomes, such as disability and dependence [24]. However, there are associations as demonstrated in Fig. 2, with vulnerabilities that are consistent across the world: female sex, being less educated (and illiteracy), lower income, lower socioeconomic status, higher disease burden, and multimorbidity.

3. Frailty and migration

Understanding whether global differences in frailty are due to ethnicity (and therefore potentially, genetic) or due to environmental factors is an important starting point to unpick frailty pathways. Migration is a unique model to examine the effects of both. For the purpose of this review, a "recent migrant" is anyone considered to be a first-generation migrant in their country of settlement. In the Netherlands, a study involving middle-aged community-dwelling participants (55 years and older) compared indigenous Dutch individuals to Turkish, Indonesian, Surinamese, and Moroccan first generation migrants [56]. Using a 45-item frailty index (TOPICS-Frailty index), after adjusting for confounders, those of Turkish, Moroccan, or Surinamese backgrounds were shown to be frailer than their Dutch counterparts; this wasn't seen with Indonesian migrants. Six different frailty component scores were separately examined: Morbidities, Activities of daily Living (ADL) limitations (both basic and instrumental), psychosocial health, health-related quality of life (HQOL), and self-rated health. All non-Dutch minorities had greater limitations in instrumental ADLs. Turkish migrants had greater limitations in all components when compared to indigenous Dutch. However, completion of instrumental ADLs is heavily biased towards cultural and local knowledge, which may be limited in migrants new to the country. The differences in frailty seen between ethnic minority groups are likely to be related to socioeconomic disadvantage [56]. Social frailty has previously been found to be higher in the Turkish and Surinamese groups in the Netherlands, as well as having higher Frailty Index scores [57]. Another Dutch study found that in young non-Dutch migrants, cardiovascular and psychiatric conditions contributed most to their disease burden. These groups are estimated to have a greater increase in future disease burden compared to their Dutch counterparts [58], and therefore, potentially more likely to be frail.

Another two large studies have looked at longitudinal data from the aforementioned SHARE study. In the initial analysis [59], out of over 95,000 participants, 7% were migrants; of these migrants, 3.4% were from LMICs, and 3.6% were from HICs. Migrants born in LMICs had higher frailty index scores than both HIC-born migrants and native-born Europeans, and this was consistent across age groups. After adjusting for confounding factors, such as age, gender and education level, there was a significant effect on frailty between migration and where participants currently live. In Northern and Western Europe, participants from LMICs had higher frailty scores compared to both HIC born migrants and indigenous Europeans; interestingly, these differences were not seen in Southern and Eastern Europe [59]. Overall, regardless of geography and migrant status, frailty itself was predictive of survival in all participants. These data show that where migrants settle has

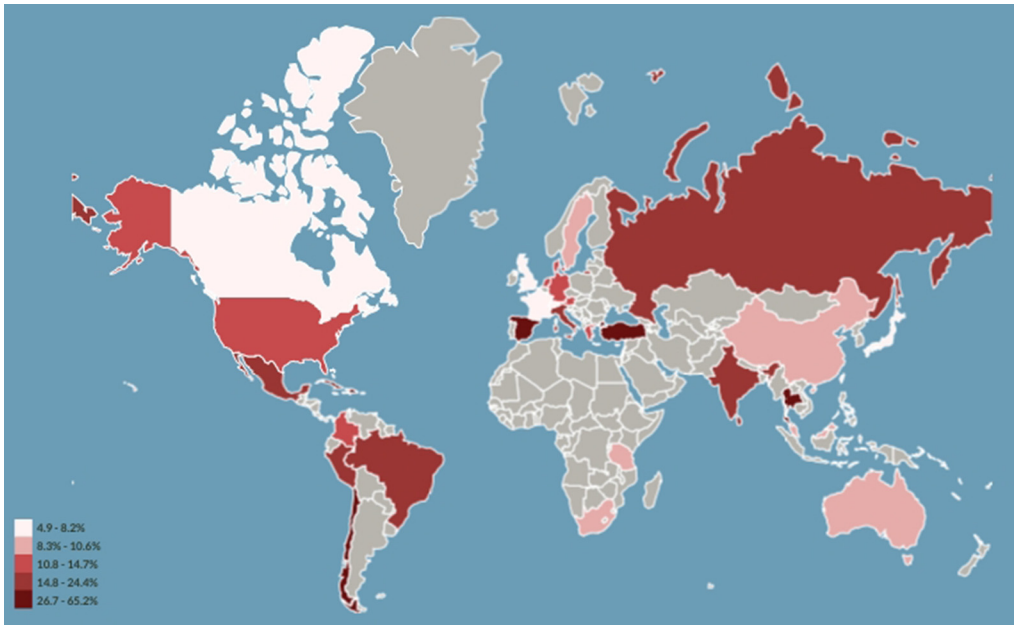

Fig. 1. Global frailty prevalence based on pooled means from studies reviewed using Fried Frailty Phenotype of adults aged > 60 years.
The countries reviewed were ranked according to frailty prevalence and then stratified into quintiles. The frailty prevalence globally ranges from 4.9–65.2%. The higher rates of frailty prevalence are exhibited in largely LMICs. The countries with the highest frailty prevalence are Thailand (65.2%, CI 57.4–73.1%) and Chile (42.6%, CI 39.8–45.4%). The lowest frailty prevalence are seen in Western HICs, such as Switzerland (5.8%, CI 3.5–8.1%) and the UK (7.8%, CI 6.9–8.7%), but this group is also made up of HICs from the far East, such as Japan (8.2%, CI 7.8–8.7%) and Taiwan having the lowest prevalence at frailty at 4.9% (CI 4.0–5.8%).

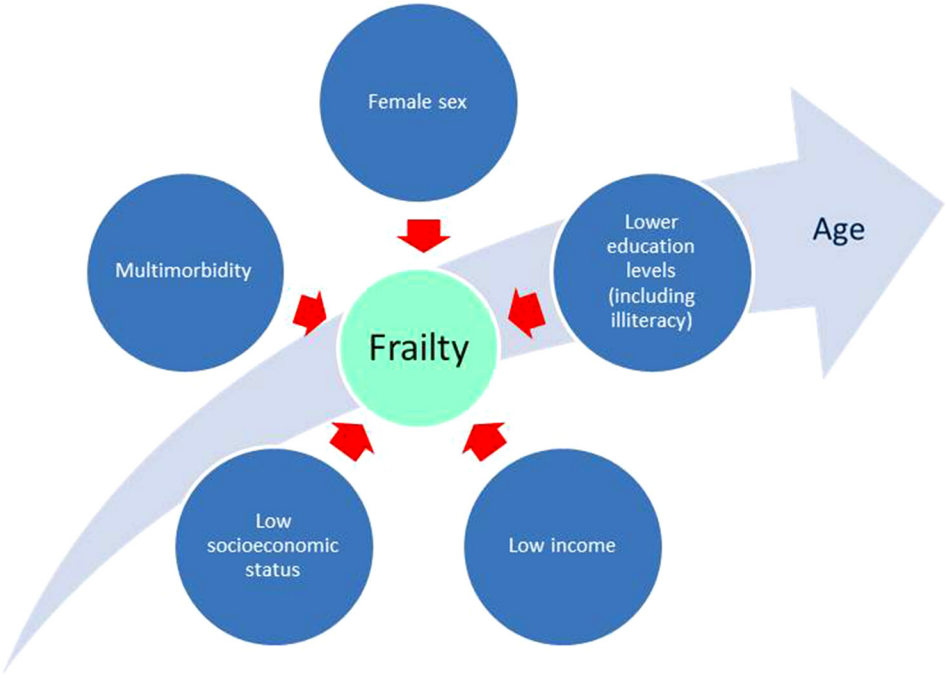

Fig. 2. Factors associated with frailty in ageing populations.
Age itself is the strongest correlator with frailty, and in general, frailty prevalence increases with age in both men and women across the world. Other factors associated with frailty persistently demonstrated in the literature in these worldwide ageing populations include: female sex, being less educated (including illiteracy), lower income, lower socioeconomic status, high disease burden and multimorbidity.

important effects on frailty, suggesting a strong environmental component. In addition, people living in Southern/Eastern Europe were had higher frailty prevalence than those living in Northern/Western Europe, suggesting that both country of origin (and therefore, by proxy, ethnicity) and country of settlement affect frailty trajectories.

A further analysis of SHARE data in 2018 analysed the effects of migrant-integration policies on frailty [60]. This cohort of SHARE included a later wave of recruitment; 9.5% of participants were migrants, 60.8% were born in LMICs, and 39.1% in HICs. Data show migrants were actually more educated compared to non-migrants, but were shorter, and were younger overall. Migrants were very slightly frailer (FI score 0.15, IQR: 0.09, 0.25) than indigenous participants at baseline (FI score 0.14, IQR 0.08, 0.22. $p < 0.001$). Those born in LMIC's had 25.8% higher frailty index scores compared to indigenous Europeans. However, frailty scores of migrants born in HICs (of varying backgrounds) were only 3.2% greater. Therefore, frailty was significantly affected by country of origin, which may be due to ethnicity or a pre-migration environment.

SHARE data shows that, within Europe, the majority of migrants have settled within Western and Northern regions. Considering indigenous Europeans, the repeat analysis confirmed that frailty index scores were higher in Southern and Eastern Europe compared to Northern and Western Europe. This could partly be explained by differences in economic stability, and therefore add weight to the argument of environmental impact, in this case, socioeconomic factors on frailty, regardless of ethnicity. Comparing migrant groups, frailty index scores were higher for those living in Northern and Eastern Europe, compared to those living in Western and Southern Europe. Cross-sectional analysis of the data confirmed this: migrants were frailer in Northern, Western and Eastern Europe than their non-migrant counterparts. In Southern Europe, after adjusting for confounders, the migrant effect was fully attenuated [60].

The Migrant Integration Policy Index ranking (MIPEX) is a proxy measure of healthcare coverage and access, and representation for migrant inclusivity [61]. SHARE data showed that in countries where MIPEX ranking indicated poorer healthcare access, frailty index scores increased progressively for all people and especially in migrants. Quality of healthcare in each country is therefore vitally important. Further cross-sectional study confirmed the association between migration and increased frailty with lower MIPEX rankings. However, attaining citizenship has been shown to moderate frailty prevalence from 16.4%–12.1%. This effect is greatest in migrants born in LMICs regardless of settlement location, and in migrants from HICs settling in Western Europe; this was seen in even the lowest ranked MIPEX countries. This suggests that gaining citizenship may be a protective factor regardless of settlement location. The reasons for this could be considered multifactorial: acculturation, greater integration, and better access to education, work and healthcare, with subsequent improvements in socioeconomic status and overall well-being.

3.1. Migration and longitudinal data

Longitudinal data for frailty is limited, and there is even less for migrants. Multilevel longitudinal analysis of the SHARE dataset has shown that frailty trajectories between migrants to Europe and indigenous Europeans converge over life courses. By the eighth and ninth decade of life, there were no differences in frailty between migrants and non-migrants. In addition, mortality rates were found to be no different between migrants and non-migrants [60].

3.2. Conclusions on migration and frailty

There is evidence that there are frailty differences seen between ethnic minorities after migration. SHARE-focused studies support global frailty data. People living in LMICs, regardless of ethnicity, have higher frailty prevalence than those living in HICs. This discrepancy for individuals persists when migrating, including when moving to areas of better economic growth and development. It has previously been suggested that migrants tend to be healthier after early migration ('healthy migrant effect'); early migrants may demonstrate lower mortality rates than non-migrants [62,63]. However, evidence from SHARE discounts this [60]. It is possible post-migration integration abrogates this.

Many migrant cohorts studied on scale are younger than non-migrant cohorts. However, migrant groups tend to exhibit higher multimorbidity; migrants may tend to be 'frailer' when younger (as seen in CHS [44] and HANDLs [43]). Despite this, overall mortality between migrants and non-migrants is not significantly different, suggesting convergence of frailty at some point as people age. Frailty is a complex

multi-stranded syndrome, where social and environmental factors impact biology, but do so in a lifelong manner. Variation exists in the rate of accumulation of risk and /or the manifestation of risk. This is intricately related to level of exposure i.e. exposure to more adversity when younger increases likelihood of accumulation of disease, multimorbidity, and frailty, regardless of ethnicity. Childhood exposure to ill health, infection, environmental stress, poor nutrition, poor sanitation, and innumerable other environmental factors (including access to and level of healthcare) have lifelong impacts. Lower childhood and adulthood socioeconomic status are independently associated with slow chair-rise times and slower walking speeds in older adults [64], which are intimately related to frailty.

CHS and other studies have suggested potential differences in clinical expression of frailty after accounting for all other covariates, which may be due to ethnicity differences. Ethnicity may enable identification towards a 'frailty genotype'. Accumulation of risk in frailty in different groups varies but how much of this is driven by intrinsic differences in ethnicity, race, or biology rather than psycho-social environmental factors, is unknown. Little data is available on the characterisation of frailty clinically or biologically.

To determine true effects of ethnicity, race, and migration on frailty, research should focus on comparing differences between those that have migrated out of their country of origin and those that have remained. No direct comparator studies assessing frailty in migrating and non-migrating groups of older people have been completed to date.

4. Limitations

There is great heterogeneity in the literature across a relatively limited breadth of studies and all research conducted to date has been observational. There is considerable variation in frailty prevalence even when the same countries are studied. There is no overall consensus of frailty prevalence globally, but some generalisations could be made. There is still no agreed measure of frailty and diagnostic criteria, meaning direct comparisons between countries can be difficult. The most commonly used measure of frailty globally was the Fried frailty phenotype, with fewer studies opting to use some form of frailty index.

The frailty phenotype represents a physical portrayal of frailty; people with cognitive impairment were excluded from the original reference group. There also remains considerable disparity in how parameters may be measured. Some studies, due to resource limits, were only able to measure four of the five parameters, making comparison difficult between studies. In addition, each of the five components can be measured in different ways; assessment of weakness and slowness could be assessed objectively by the use of hand grip strength and gait speed, but some studies have relied on self-reported data, which is vulnerable to reporting bias.

The strengths of the frailty phenotype are that it has been successfully used in various settings, across cultural and ethnic groups [24]. In the African HAALSI study [10] various forms of the frailty phenotype were used successfully, meaning it can be carried out in rural and resource poor countries. However, HAALSI perfectly demonstrates heterogeneity difficulties; in their cohort, frailty prevalence varied according to 'frailty score variants' (from 3% to 9.6%). Each of these 'frailty score variants' was made up of various combinations of phenotype components depending on how they were measured [10]. This demonstrates difficulties in comparing characteristics of frailty in different groups. It is particularly to important note that studies carried out in LMICs were more likely to have component measures missing.

The frailty phenotype may also fail to take into account other factors contributing to frailty, such as cognition, psychological, and social aspects of frailty. Use of a frailty index over time may provide observational opportunities for rate of deficit accumulation, frailty trajectories, and insight to underlying processes. Higher frailty scores are consistently associated with increased risk of disease, and mortality risk [65]. A limitation of studies that use a frailty index is that they often rely on participant reported data; cultural variations in understanding of illness, disease, and function may affect this. A frailty index may include cognitive deficits, but most studies included few cognitive deficits in their model. Similar to Fried's phenotype criteria, most frailty indices have very few cognitive elements – and this highlights another major drawback with both measures. Frailty and cognitive impairment have a close relationship; frailty is an independent predictor of dementia incidence [66]. This has profound implications for understanding and predicting future disability and dependence. There may be shared physiological pathways between frailty and cognitive impairment; how this differs across ethnicities and backgrounds is unknown. Few studies globally have focused on cognitive aspects of frailty, likely due to assessment tool limitations. There are likely further sub-cohorts of frail older adults with cognitive impairment who have increased mortality [67], and higher degrees of dependence.

Many frailty measures have not been validated in different ethnicities. This makes it difficult to ascertain how accurately we are measuring frailty prevalence in different countries and ethnic groups. Examining frailty between older Mexican Americans and older European Americans found that when using 'conventional criteria' in frailty phenotype measures, a higher proportion Mexican Americans were found to be frail compared to European Americans (11.3% versus 7.0%) [68]. However, after adjusting walking speed, grip strength, and energy expenditure to ethnicity specific cut-offs, prevalence of frailty in Mexican Americans fell by 12%, and prevalence of frailty in European Americans rose by 41%. Frailty phenotype measures have already demonstrated heterogeneity, and this may further be compounded by ethnicity. It is likely frailty indices suffer from the same bias, but potentially to a lesser degree. The electronic Frailty Index (eFI), a simple-to-use frailty index for use in primary care in the UK [69], has recently had convergence validation performed on a diverse community-based older population; the Community Ageing Research 75+ (CARE 75+) cohort. Of the participants, 15% were 'non-white'; 14% from a South Asian background specifically. Convergence validation showed strong correlation between eFI and both a research standard frailty index and the Edmonton Frailty Scale. There was moderate correlation between eFI and frailty phenotype model and Clinical Frailty Scale [70]. Some degree of accuracy of frailty trajectory may be lost in different ethnic groups, particularly using frailty measures where conventional standards are used. Further research should focus on cross-sectional validation, and development of frailty tools with standards that are ethnicity-specific.

We have considered differences between LMICs and HICs. However, country of origin and economic status are not true reflections of 'biological ethnicity'. This is a major limitation in comparing frailty studies performed at scale; any characterisations made are generalisations. A country such as India may have multiple ethnicities, with potential genetic differences that may modify frailty risk. This may be confounded further by migration. How we define race, ethnicity, and migration are major limitations in epidemiological studies in general. Humans have been migrating for thousands of years, and defining migration in the modern age is complex. Migrants are easier to identify in Europe compared to America; 'historical migration' has had profound impacts on ethnicity. One of the best examples of this is in Latin and South America. The impacts of slavery to the region from the African continent, and migration from Europe changed the demographics of local indigenous peoples in just a few hundred years. Defining ethnicity in modern countries such as Brazil is incredibly difficult [71]. North America may be an ideal country to complete ethnicity-specific studies on frailty as almost all people living there are migrants.

5. Conclusion

By looking at frailty in both a global context, and considering migration to the West, older people living in LMICs are more likely to be frail compared to older people living in HICs. However, differences in

frailty remain uncharacterised. There are clear associations with frailty, which are consistent across both LMIC and HICs. These include: age, female sex, lower education attainment, lower household income, high disease burden, and multi-morbidity. However, older people with frailty in LMICs are more likely to have disability and dependence.

Ethnic minority migrants living in HICs are more likely to be frail compared to their indigenous counterparts and they tend to exhibit higher frailty prevalence at younger ages. This effect is attenuated if the migrant's country of origin is a HIC. In Europe, migration to the relatively poorer South (and potentially East) makes likelihood of frailty equivalent to that of the indigenous population. Risk of frailty reduces over time in migrants who have been settled in a host country for longer, have achieved citizenship, and have greater societal integration. Over time, the risk of death for both migrants and indigenous peoples in HICs is the same, suggesting that frailty trajectories converge, and/or there is an element of survivor bias. There is increasing evidence that factors extrinsic to ethnicity affect frailty risk and trajectory. Frailty trajectory may be key here, as we hypothesise that ethnicity may play a role in when (and potentially how) frailty starts to manifest, and is prone to change over time. This vulnerability to change could potentially be biologically determined. This is important as we may be able to target interventions differently in different groups to prevent or reverse frailty. Understanding if frailty is both clinically and biologically different is fundamentally important. There is no detailed data characterising frailty in one specific ethnic group, and especially no comparators with migrating people of the same ethnicity to assess the impacts of environment. Further research such as this, especially in a longitudinal manner, would be the ideal model to elucidate frailty pathways.

Contributors

Zeinab Majid carried out the initial literature search, assimilation of data and main manuscript writing.

Carly Welch made a significant contribution to the drafting of the manuscript.

Justine Davies made a significant contribution to the drafting of the manuscript.

Thomas Jackson made a significant contribution to the drafting of the manuscript.

Conflict of interest

The authors declare that they have no conflict of interest.

Funding

Dr Zeinab Majid is funded by a National Institute for Health (NIHR) Academic Clinical Fellowship. Dr Carly Welch is funded through a Medical Research Council – Versus Arthritis Centre for Musculoskeletal Ageing Research PhD studentship. Dr Thomas Jackson is funded by the West Midlands NIHR Clinical Research Network. The views expressed are those of the authors and not necessarily those of the NHS, the NIHR, or the Department of Health and Social Care.

Ethics

Our review is a narrative review and did not involve research with human participants.

This was a literature based review; systematic searches were done using online medical journal databases, as well as review of the grey literature, and all references have been cited. We feel our work, although not necessarily having generated new data, has extensively and comprehensively brought together frailty prevalence data from numerous, usually fairly heterogenous sources. We hope the review itself has contextualised these data in both a global health and clinical framework to help understand frailty pathways.

Provenance and peer review

This article has undergone peer review.

Acknowledgements

Dr Huma Naqvi.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.maturitas.2020.05.010.

References

[1] U. Nations, World Population Prospects 2019: Highlights, United Nations, 2019.
[2] W.H. Organisation, Demographic Trends, Statistics and Data on Ageing, Available from: (2012) http://www.euro.who.int/en/health-topics/Life-stages/healthy-ageing/data-and-statistics/demographic-trends,-statistics-and-data-on-ageing.
[3] L.P. Fried, et al., Frailty in older adults: evidence for a phenotype, J. Gerontol. A Biol. Sci. Med. Sci. 56 (3) (2001) M146–56.
[4] A. Clegg, et al., Frailty in elderly people, Lancet 381 (9868) (2013) 752–762.
[5] E.M. Eeles, et al., The impact of frailty and delirium on mortality in older inpatients, Age Ageing 41 (3) (2012) 412–416.
[6] K. Rockwood, et al., A brief clinical instrument to classify frailty in elderly people, Lancet 353 (9148) (1999) 205–206.
[7] K. Rockwood, A. Mitnitski, Frailty in relation to the accumulation of deficits, J. Gerontol. A Biol. Sci. Med. Sci. 62 (7) (2007) 722–727.
[8] M. Cesari, et al., The frailty phenotype and the frailty index: different instruments for different purposes, Age Ageing 43 (1) (2013) 10–12.
[9] T.Ao.M. Sciences, Multimorbidity: a Priority for Global Health Research, (2018).
[10] C.F. Payne, et al., Prevalence and correlates of frailty in an older rural African population: findings from the HAALSI cohort study, BMC Geriatr. 17 (1) (2017) 293.
[11] P. Villacampa-Fernández, et al., Frailty and multimorbidity: two related yet different concepts, Maturitas 95 (2017) 31–35.
[12] V.S. Periyakoil, Building a culturally competent workforce to care for diverse older adults: scope of the problem and potential solutions, J. Am. Geriatr. Soc. 67 (S2) (2019) S423–S432.
[13] National Research Council (US), Panel on Race, E., And health in later life, in: A.N. Bulatao RA (Ed.), Understanding Racial and Ethnic Differences in Health in Late Life: A Research Agenda, 8, stress ed, USA National Academies Press, US), 2004.
[14] R.S. Hoehn, et al., Opportunities to improve care of hepatocellular carcinoma in vulnerable patient populations, J. Am. Coll. Surg. 224 (4) (2017) 697–704.
[15] M. Evandrou, et al., Ethnic inequalities in limiting health and self-reported health in later life revisited, J. Epidemiol. Commun. Health 70 (7) (2016) 653–662.
[16] N.R. Smith, Y.J. Kelly, J.Y. Nazroo, Intergenerational continuities of ethnic inequalities in general health in England, J. Epidemiol. Commun. Health 63 (3) (2009) 253–258.
[17] P.H. England, Public Health Outcomes Framework: Health Equity Report - Focus on Ethnicity, (2017).
[18] R.S. Wasim Hanif, Diabetes and cardiovascular risk in UK South Asians: an overview, Br. J. Cardiol. 25 (2018) s8–s13.
[19] R.M. Collard, et al., Prevalence of frailty in community-dwelling older persons: a systematic review, J. Am. Geriatr. Soc. 60 (8) (2012) 1487–1492.
[20] K. Harttgen, et al., Patterns of frailty in older adults: comparing results from higher and lower income countries using the Survey of Health, Ageing and Retirement in Europe (SHARE) and the Study on Global AGEing and Adult Health (SAGE), PLoS One 8 (10) (2013) e75847.
[21] K. Rockwood, A. Mitnitski, C. MacKnight, Some mathematical models of frailty and their clinical implications, Rev. Clin. Gerontol. 12 (2002) 109–117.
[22] D.D. Siriwardhana, et al., Prevalence of frailty and prefrailty among community-dwelling older adults in low-income and middle-income countries: a systematic review and meta-analysis, BMJ Open 8 (3) (2018) e018195.
[23] T.N. Nguyen, R.G. Cumming, S.N. Hilmer, *A review of frailty in developing countries*, J. Nutr. Health Aging 19 (9) (2015) 941–946.
[24] J. At, et al., Frailty and the prediction of dependence and mortality in low- and middle-income countries: a 10/66 population-based cohort study, BMC Med. 13 (2015) 138.
[25] F.A. Da Mata, et al., Prevalence of frailty in Latin America and the Caribbean: a systematic review and meta-analysis, PLoS One 11 (8) (2016) e0160019.
[26] W.H. Organisation, Good Health Adds Life to Years: Global Brief for World Health Day 2012, (2012) Geneva.
[27] E.G. Lewis, et al., The prevalence and characteristics of frailty by frailty phenotype in rural Tanzania, BMC Geriatr. 18 (1) (2018) 283.
[28] I.A.G. Aboderin, J.R. Beard, Older people's health in sub-Saharan Africa, Lancet 385

(9968) (2015) e9–e11.
[29] H. Arai, et al., Japan as the front-runner of super-aged societies: perspectives from medicine and medical care in Japan, Geriatr. Gerontol. Int. 15 (6) (2015) 673–687.
[30] G. Kojima, et al., Prevalence of frailty in Japan: a systematic review and meta-analysis, J. Epidemiol. 27 (8) (2017) 347–353.
[31] C.Y. Chen, et al., The prevalence of subjective frailty and factors associated with frailty in Taiwan, Arch. Gerontol. Geriatr. 50 (Suppl 1) (2010) S43–7.
[32] F.A. Mohd Hamidin, et al., Prevalence of frailty syndrome and its associated factors among community-dwelling elderly in East Coast of Peninsular Malaysia, SAGE Open Med. 6 (2018) p. 2050312118775581.
[33] J. Sathasivam, et al., Frail elders in an urban district setting in Malaysia: multi-dimensional frailty and its correlates, Asia. J. Public Health 27 (8 Suppl) (2015) 52s–61s.
[34] M. Badrasawi, S.S, A.M. Zahara, K.A.S. Devinder, Nutritional, physical and cognitive status among pre-frail and frail malaysian older adults, Malays. J. Nutr. 22 (3) (2016) 351–361.
[35] D.D. Siriwardhana, et al., Prevalence of frailty in rural community-dwelling older adults in Kegalle district of Sri Lanka: a population-based cross-sectional study, BMJ Open 9 (1) (2019) e026314.
[36] Y. Kashikar, N.A, Prevalence and determinants of frailty in older adults in India, Indian Journal of Gerontology 30 (2016) 364–381.
[37] S. Devkota, et al., Prevalence and determinants of frailty and associated co-morbidities among older Gurkha welfare pensioners in Nepal, Geriatr. Gerontol. Int. 17 (12) (2017) 2493–2499.
[38] M. Iwasaki, et al., Association between objectively measured chewing ability and frailty: a cross-sectional study in central Thailand, Geriatr. Gerontol. Int. 18 (6) (2018) 860–866.
[39] T.R. Khan ATA, Q. Amjad, Assessment and management of geriatric care in Pakistan, J. Geronto. Geriatr. Res. (7) (2018) 488.
[40] S.N. Zafar, et al., Health and needs assessment of geriatric patients: results of a survey at a teaching hospital in Karachi, J. Pak. Med. Assoc. 56 (10) (2006) 470–474.
[41] K. Qureshi, Ageing: Gender, Social Class and Health in Pakistan, (2017) http://cppg.fccollege.edu.pk/ageing-gender-social-class-and-health-in-pakistan/.
[42] P.A. Braveman, et al., Socioeconomic disparities in health in the United States: what the patterns tell us, Am. J. Public Health 100 (Suppl 1) (2010) S186–S196.
[43] F.R. Griffin, et al., Frailty in a racially and socioeconomically diverse sample of middle-aged Americans in Baltimore, PLoS One 13 (4) (2018) e0195637.
[44] C. Hirsch, et al., The association of race with frailty: the cardiovascular health study, Ann. Epidemiol. 16 (7) (2006) 545–553.
[45] K.J. Ottenbacher, et al., Frailty in older mexican americans, J. Am. Geriatr. Soc. 53 (9) (2005) 1524–1531.
[46] S. Kyriakos, K.E. Markides, Laura A. Ray, M. Kristen Peek, Census disability rates among older people by race/ethnicity and type of Hispanic origin, The Health of Aging Hispanics: The Mexican Origin Population, Springer, New York, NY, 2007.
[47] R. Turner Goins, M. Schure, B. Winchester, Frailty in older american indians: the native elder care study, Gerontol. Geriatr. Med. 5 (2019) p. 2333721419855669-2333721419855669.
[48] Z. Hyde, et al., Prevalence and incidence of frailty in Aboriginal Australians, and associations with mortality and disability, Maturitas 87 (2016) 89–94.
[49] Health, A.I.o. And Welfare, the Health and Welfare of Australia's Aboriginal and Torres Strait Islander People: An Overview 2011, AIHW, Canberra, 2011.
[50] S.T. Patrick Barrett, Sharon Kletchko, Faye Ryan, The Living Environments of Community-Dwelling Older People who Become Frail: Another Look at the Living Standards of Older New Zealanders Survey, (2020).
[51] Y. Yang, L.C. Lee, Dynamics and heterogeneity in the process of human frailty and aging: evidence from the U.S. Older adult population, J. Gerontol. B Psychol. Sci. Soc. Sci. 65B (2) (2010) 246–255.
[52] A. Marshall, et al., Cohort differences in the levels and trajectories of frailty among older people in England, J. Epidemiol. Community Health 69 (4) (2015) 316–321.
[53] H. Horder, et al., Secular trends in frailty: a comparative study of 75-year olds born in 1911-12 and 1930, Age Ageing 44 (5) (2015) 817–822.
[54] R. Yu, et al., Trajectories of frailty among Chinese older people in Hong Kong between 2001 and 2012: an age-period-cohort analysis, Age Ageing 47 (2) (2018) 254–261.
[55] M.K. Peek, et al., Social support, stressors, and frailty among older mexican american adults, J. Gerontol. 67 (6) (2012) 755–764.
[56] C.B. Franse, et al., Ethnic differences in frailty: a cross-sectional study of pooled data from community-dwelling older persons in the Netherlands, BMJ Open 8 (8) (2018) e022241.
[57] M.A.L.M. van Assen, et al., Measuring frailty in Dutch community-dwelling older people: reference values of the Tilburg Frailty Indicator (TFI), Arch. Gerontol. Geriatr. 67 (2016) 120–129.
[58] U.Z. Ikram, et al., The disease burden across different ethnic groups in Amsterdam, the Netherlands, 2011–2030, Eur. J. Public Health 24 (4) (2013) 600–605.
[59] T.D. Brothers, O. Theou, K. Rockwood, Frailty and migration in middle-aged and older Europeans, Arch. Gerontol. Geriatr. 58 (1) (2014) 63–68.
[60] G.J. Walkden, et al., Frailty in older-age European migrants: cross-sectional and longitudinal analyses of the Survey of Health, Aging and Retirement in Europe (SHARE), Soc. Sci. Med. 213 (2018) 1–11.
[61] Migrant Integration Policy Index.
[62] R.A. Hummer, et al., Race/ethnicity, nativity, and U.S. Adult mortality, Soc. Sci. Q. 80 (1) (1999) 136–153.
[63] B. Rechel, et al., Migration and health in an increasingly diverse Europe, Lancet 381 (9873) (2013) 1235–1245.
[64] K. Birnie, et al., Socio-economic disadvantage from childhood to adulthood and locomotor function in old age: a lifecourse analysis of the Boyd Orr and Caerphilly prospective studies, J. Epidemiol. Community Health 65 (11) (2011) 1014–1023.
[65] X. Li, et al., The frailty index is a predictor of cause-specific mortality independent of familial effects from midlife onwards: a large cohort study, BMC Med. 17 (1) (2019) 94.
[66] N.T. Rogers, A. Steptoe, D. Cadar, Frailty is an independent predictor of incident dementia: evidence from the English Longitudinal Study of Ageing, Sci. Rep. 7 (1) (2017) 15746.
[67] Q. Hao, et al., Frailty and cognitive impairment in predicting mortality among oldest-Old people, Front. Aging Neurosci. 10 (2018) p. 295-295.
[68] S.E. Espinoza, H.P. Hazuda, Frailty in older Mexican-American and European-American adults: is there an ethnic disparity? J. Am. Geriatr. Soc. 56 (9) (2008) 1744–1749.
[69] A. Clegg, et al., Development and validation of an electronic frailty index using routine primary care electronic health record data, Age Ageing 45 (3) (2016) 353–360.
[70] C. Brundle, et al., Convergent validity of the electronic frailty index, Age Ageing 48 (1) (2018) 152–156.
[71] P. Fry, The politics of « racial » classification in Brazil, J. La Sociã©tã© Des Amã©ricanistes 95 (2) (2009) 261–282.