REVIEW

Do Interventions Reducing Social Vulnerability Improve Health in Community Dwelling Older Adults? A Systematic Review

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Background: Social vulnerability occurs when individuals have been relatively disadvantaged by the social determinants of health. Complex interventions that reduce social vulnerability have the potential to improve health in older adults but robust evidence is lacking.

Objective: To identify, appraise and synthesize evidence on the effectiveness of complex interventions targeting reduction in social vulnerability for improving health related outcomes (mortality, function, cognition, subjective health and healthcare use) in older adults living in the community.

Methods: A mixed methods systematic review was conducted. Five databases and targeted grey literature were searched for primary studies of all study types according to predetermined criteria. Data were extracted from each distinct intervention and quality was assessed using the Mixed Methods Appraisal Tool. Effectiveness data were synthesized using vote counting by direction of effect, combining p values and Albatross plots.

Results: Across 38 included studies, there were 34 distinct interventions categorized as strengthening social supports and communities, helping older adults and their caregivers navigate health and social services, enhancing neighbourhood and built environments, promoting education and providing economic stability. There was evidence to support positive influences on function, cognition, subjective health, and reduced hospital utilization. The evidence was mixed for non-hospital healthcare utilization and insufficient to determine effect on mortality.

Conclusion: Despite high heterogeneity and varying quality of studies, attention to reducing an older adult's social vulnerability assists in improving older adults' health.

Keywords: social determinants, older adults, complex interventions, social frailty

Background
What is Social Vulnerability

When two older adults have the same medical conditions and the same degree of frailty, the difference between living independently in the community with supports and requiring admission to a hospital or long-term care facility can be explained by social circumstances. Social vulnerability (SV) is defined as the degree to which a person's overall social circumstances leave them susceptible to further insults (ie health or socially related adverse events).[1]

Social vulnerability occurs when individuals have been relatively disadvantaged by the broader conditions in which they were born, lived, worked and aged; also known as the social determinants of health.[2] Socially vulnerable individuals have variable presentations. For example, an older woman living below the poverty line in a racialized neighbourhood may be vulnerable due to economic and housing reasons but has a robust social network of friends and family. Another example of social vulnerability is the reclusive and wealthy older man who has no one to call in the event of a natural disaster. The commonality is the inability to respond in times of crises due to a social reason (ie poverty or isolation) rather than a health-related reason. Unequal determinants directly impact individuals, but arise from complex political,

social and economic structures. For this reason, the social determinants of health (SDOH) and social vulnerability are often conceptualized through ecological models.[3–5]

How SV Influences Health & How Reducing SV Might Work

The link between SDOH and health is well documented, accounting for 30–55% of adverse health outcomes globally, such as mortality from chronic diseases.[6] The construct of social vulnerability as the manifestation of poor social determinants in an individual is less prominent; nonetheless, being socially vulnerable has been associated with greater mortality,[5,7–10] risk of cognitive decline[11] and disability,[9] and likelihood of long-term care admission.[12] Social divergence theory suggests socioeconomic disparities accumulate with time, resulting in worse health inequities in older age, which are compounded by shrinking social circles due to infirmity and death of friends and family members.[13] Figure 1 shows the associations between SDOH, SV and health outcomes and helps to explain how interventions reducing social vulnerability through the SDOH might work.

Why It is Important to Do This Review

Studying social vulnerability is challenging as complex interrelated pathways by which upstream social factors influence health to do not allow for hypothesis testing through traditional research methods. Moreover, since multicomponent intervention studies rarely distinguish the social components of the intervention, there is little evidence suggesting what can be done to reduce health inequities through the addition of social programs in real life situations. As social determinants research "for the most part exists outside the literature concerned with effectiveness of interventions",[14] especially in non-hospitalized populations,[15,16] this is one gap this review will try to address. To our knowledge, no previous systematic review has attempted to collate and evaluate complex interventions based on a strong social intervention component in older adults. Additionally, for older adults with multiple medical conditions, it is nearly impossible to separate out those who are purely frail from those who are purely socially vulnerable. By accepting that multiple things can go wrong simultaneously in an individual, interventions aimed at social vulnerability cannot ignore medical frailty and vice versa; to do so would continue to fractionate research areas, moving away from treating individuals holistically. Instead, the lens used here to study social interventions within complex interventions accounts for the broader context where older adults would presumably receive both medical and social supports. Combined with a systematic mixed-methods literature review methodology, the authors attempt to answer the broad research question: is there evidence to support the notion that complex interventions targeting reduction in social vulnerability improve health outcomes for older adults living in the community?
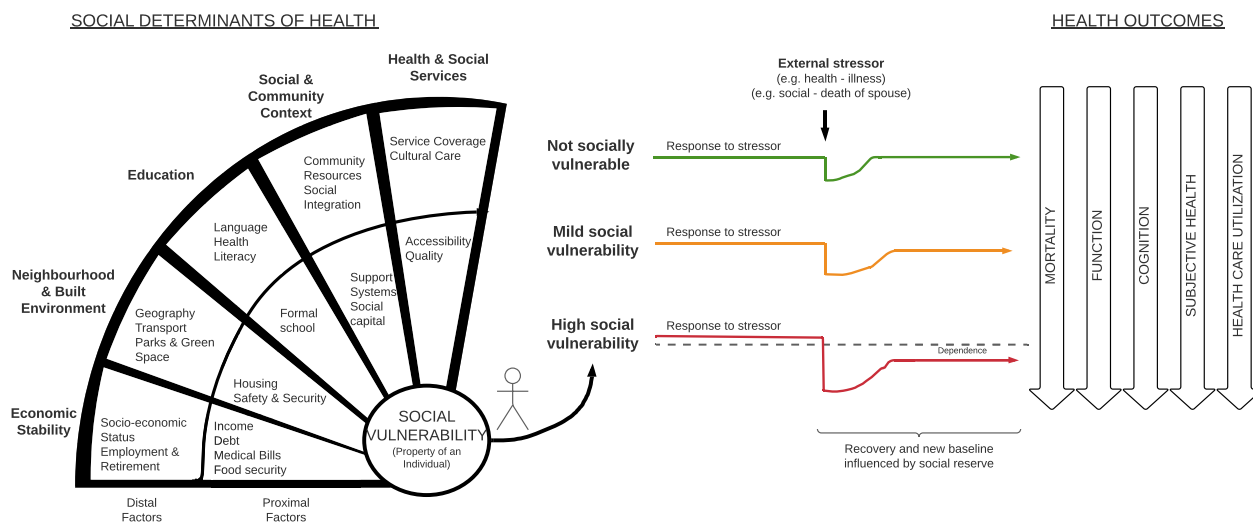

Figure 1 Conceptual model linking the social determinants of health to social vulnerability and health outcomes.

Methods

Review Objectives

To identify, appraise and synthesize evidence on the effectiveness of complex interventions where a main component of the intervention targets reduction in social vulnerability for improving health related outcomes (mortality, function, cognition, subjective health and healthcare use) in older adults living in the community.

Study Design, Search Strategy & Selection Criteria

This systematic review employs a mixed methods approach to synthesizing complex interventions following PRISMA-CI guidelines.[17,18] Five databases were searched for primary studies: Medline, Cochrane Library (CENTRAL), EPPI-Centre's Trials Registrar of Promoting Health Interventions, Campbell Collaboration, and Social Sciences Citation Index. The search strategy in Medline was approved by a medical librarian using the Peer Review Electronic Search Strategies (PRESS) checklist,[19] then translated to the remaining databases (Supplement A provides the complete search strategy). The last search was conducted on May 18, 2021. Reference lists of included studies were also searched. Due to the nature of the interventions of interest, there was a concurrent search of grey literature to find interventions conducted by governments, non-profit or volunteer organizations.[20] This included a targeted website search of known national and international organizations who fund, implement or evaluate social interventions (Administration for Community Living, The Care Policy and Evaluation Centre, Government of Canada, HelpAge International, The International Federation on Ageing and the World Health Organization).

Inclusion criteria is fully described in Table 1 using the PICOT approach. Quantitative, qualitative or mixed studies were included if they investigated complex interventions targeting reductions in social vulnerabilities through the SDOH in a community-dwelling older adult population, and evaluated a priori outcomes of mortality, function, cognition, self-assessed health, hospital use or other healthcare use (primary care visits to doctors or nurses). A common pitfall in complex intervention reviews is the ambiguity of included studies; hence Supplement A3 provides a full list of exclusion criteria with examples. Although closely related, this is not a review of interventions targeting only social isolation, physical fitness or falls prevention, which already have considerable literature bases and excellent systematic reviews.[21–27] The search was limited to English studies from the last ten years, enabling the assessment of practices and challenges relevant in the current political and healthcare climate. This review looked exclusively at active interventions, hereby called social vulnerability interventions, rather than broad governmental policies influencing social vulnerability.

Data Collection & Extraction

Citations were imported into EndNote[31] for de-duplication and title and abstract screening. Then full texts were assessed for relevance to inclusion criteria and reasons for exclusions were recorded. Screening and extraction was conducted by the primary author (JM). Relevant data was collected using a piloted data extraction form (Supplement B) to collect information on: (1) general information, (2) study design (3) population (4) intervention details (5) results and outcomes (6) key author conclusions. Methodological quality was assessed using the Mixed Methods Appraisal Tool (MMAT).[32]

Data Synthesis

Evidence was synthesized using an integrated and aggregated synthesis approach following the Joanna Briggs Institute recommendations.[33] Due to the heterogeneity of the studies' interventions, populations and outcomes/measures, a meta-analysis was not possible as few studies reported sufficient data to calculate standardized effect sizes; nonetheless, three methods of quantitative synthesis were used to answer the primary objective: (1) all studies were synthesized using vote counting based on direction of effect,[34,35] (2) for studies including a control group, p values were combined using Fisher's method to answer the question: "is there evidence of a positive effect on outcome in at least one study" to demonstrate the intervention is beneficial compared to the control,[34] and (3) Albatross plots were constructed for studies with a control group and calculable mean differences, which uses 2 sided p values plotted against sample sizes to estimate a magnitude of intervention effect.[36] Full details and calculations are described in Table 2. Data extraction and synthesis was conducted by one author (JM). A second reviewer also extracted, assessed risk of bias and performed the

Table 1 Search Strategy: Inclusion Criteria, PICOT Format

	Criteria	Details
Inclusion Criteria		
Population (P)	Older adults 60 years of age or older.	Targeted or actual population mean or median age ≥ 60 years old. An established geriatric filter was used in the search strategy.[28]
Intervention (I)	Community-based complex interventions where a main component of the intervention targets at least one social determinant of health, reducing social vulnerability, in the following categories: ● Economic stability ● Education ● Neighbourhood and Built Environment ● Social and Community Context ● Health & Social Services	Guided by left side of the conceptual model in Figure 1. The SDOH categorization comes from the US Department of Health and Human Services.[29] The individual determinants in Figure 1 were chosen by the authors based on expertise of the SDOH in older adults, compiled from SDOH lists by the World Health Organization, Centers of Disease Control and Prevention and the Government of Canada.[6,29,30] The definition of complex intervention follows the Medical Research Council guidance.[17]
Comparison (C)	No comparison, passive comparison (standard of care) or active comparison (variation of intervention) accepted.	Terms comparison and control group used interchangeably in this review.

Outcome (O)	1) Measurable health outcomes:
	   a. Mortality
	   b. Function
	   c. Cognition
	   d. Subjective health or health related quality of life
	2) Utilization of healthcare services
	   a. Hospital or Emergency Department (ED) use
	   b. Other healthcare use –primary care provider visits (physicians or nurses)
		These outcomes were chosen a priori for their relevance to the health of older adults. No limits were placed on type of outcome measurement.

Type of Study (T)	Any interventional study or evaluative study. Qualitative, quantitative or mixed methods.	Expert opinions, reviews, and commentaries were excluded. Protocol papers were excluded, but corresponding authors were contacted for results if the intervention fit the remaining criteria.

quantitative data synthesis on a randomly sampled 25% of the included papers to check that the data extraction and synthesis was consistent (audit results also shown in Supplement D3 and E3). All analyses were conducted with RStudio and Excel.

Results
Results of Search
Of the 5918 citations retrieved, 567 were duplicates, 4457 were excluded after title and abstract screening, and 174 full text articles were obtained (see Figure 2). This review included a total of 38 studies, representing 34 distinct interventions. 52.9% of studies were conducted in the United States.

Description of Interventions
Table 3 (with full details in Supplement C) summarizes the characteristics of each complex intervention and target population, grouped into five categories of reducing social vulnerability. On average, participants were 74.9 years old, 69.6% female and 50.2% lived alone. Social workers and nurses were the most prevalent trained professionals.

Lasting between 10 weeks to 3 years, there were 12 weekly or biweekly programs aimed at strengthening the social supports and communities where older adults live. Eight involved group activities in senior centers, community or public

Table 2 Methods of Quantitative Data Synthesis, organized by descending amount of information provided by synthesis method

Question	Method	Calculation
What is the estimated magnitude of the intervention effect on outcome?	Albatross plot	1. Gather two-tailed p value and direction of effect 2. Plot p value (x-axis) by sample size (y-axis) 3. Estimate effect size contours for mean difference (most common measure in this review). Equation and effect sizes from Harrison et al (2017): $N = \left(\frac{4SD^2}{MD^2}\right)Z_p^2$ N=sample size, SD = standard deviation, MD = mean difference, Z = Z-statistic, p = p-value N.b. Only studies with a control or comparison group where mean differences could be calculated were included in Albatross plots.
Is there evidence of a positive effect on outcome in at least one study/intervention?	Combining p values	1. Covert two-tailed p value to one-tailed p value in direction of effect: $p1 = \frac{p2}{2}$ or $p1 = 1 - \left(\frac{p2}{2}\right)$ 2. Combine using Fisher's method: $X_{2k}^2 \doteq 2 \sum_{i=1}^{k} \ln(p_i)$ where p_i is the p-value for the ith hypothesis test 3. Interpret one sided p value against H_0 (no effect in any study)
Is there any evidence of effect?	Vote counting and sign test	1. Count studies with findings in one direction and compare to studies with findings in opposite direction a. To count direction of effect when there are multiple measures within same outcome domain: report direction (positive or negative) when combined outcomes >70% in same direction, report mixed effects when combined outcomes <70% consistency in one direction following the method by Thomson et al (2013)[37] 2. Calculate sign test as a simple binomial experiment (mixed votes excluded from total in sign test) 3. Interpret p value against H_0 (there is an equal number of "signs" or studies) N.b. Vote counting by direction of effect, not by statistical significance. Nonetheless, statistical significance, set at p<0.05, was recorded.

spaces[21,38–45] and 4 involved matched volunteers facilitating social activities.[46–49] The interventions varied from organized group activities[38,39,41–43,45] to sessions promoting health literacy or knowledge of community assets.[21,39,43]

Ranging from 4 to 52 weeks, some interventions helped older adults and their caregivers navigate health and social services. Navigators were community health workers or volunteers,[50–52] social workers[53–56] or consisted of multi-disciplinary teams.[57–63] All took place at home, but 4 were initiated during or shortly after a hospital admission.[50,51,54–56] The Community Aging in Place: Advancing Better Living for Elders (CAPABLE) intervention (and its variations) is noteworthy as it is one of the few that has been implemented in multiple states and cities and has a large evidence base (five studies in 6 citations included for this review).[57–62]

Six interventions worked to enhance the neighbourhood or home built environment. Half provided social services, personalized care coordination, and environmental hazard reduction to affordable housing buildings.[64–66] Two offered private home modifications for safety[67,68] and 1 provided accommodations for an adult in need by placing them in a home of an approved Shared Lives carer.[69]
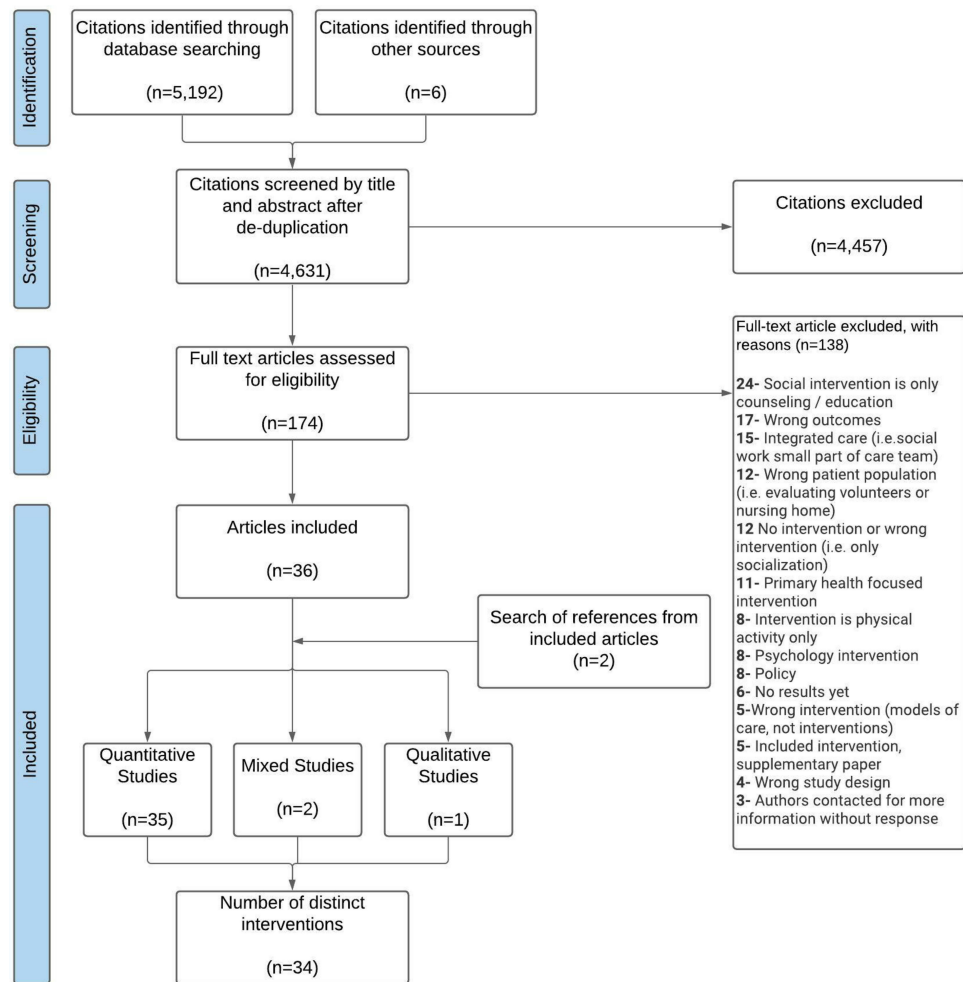
Figure 2 Flowchart of study selection.

Two interventions provided financial assistance to older adults in the form of supplemental income[70,71] or medication co-payment assistance,[72] both followed for 18 months. Three interventions mainly focused on education: 2 as college programs designed for seniors[73,74] and 1 for nutrition.[75]

Description of Study Designs and Quality Assessment

Across all studies, 35 reported only quantitative outcomes, 2 studies used a mixed methodology and one study reported qualitative outcomes. Of the quantitative studies, 9 were randomized controlled trials (RCTs),[38–40,51,58,59,61,70,75] 7 were quasi-experimental studies or longitudinal cohort studies with a control group (hereafter called controlled before after (CBA)),[41,43,47,62,64,67,68] 3 were retrospective cohort studies (RCS),[46,54,65] and 1 study conducted a cross-sectional survey (XCS).[69] The remaining quantitative studies did not have a control group. The mean and median sample sizes of all quantitative studies were 6908 and 242 participants, respectively, ranging from 12 to 172,965 participants. The largest studies were CBA or RCS in study design. Interviews were conducted with 6, 11 and 17 participants in the mixed methods or qualitative studies.

A summary of the individual MMAT scores per question and summary scores per study design are available in Supplement D. No patterns emerged when cross tabulating intervention category with study design. Overall, the quality of the included studies were poor or moderate, with only four studies matching all criteria and deemed high quality.[47,54,59,69] Poor quality studies were not excluded from synthesis.

Table 3 Characteristics and Population of Interventions Included in Review, by Five Categories of Reducing Social Vulnerability

Authors, Reference, Year (Location)	Intervention	Target Population
Intervention Category = [Strengthening] Social and Community Context		
Bae et al, 2019[38] (Takahama City, Japan)	Kenkojiseichi combines group based physical, cognitive, and social activities (16 times each) in 90-minute sessions twice per week for 24 weeks. Supervised sessions consisted of condition checks, stretching, and main activities, followed by report writing and discussion.	Older adults 60 years+ with mild cognitive impairment and without a certification of needing care from Japan's long term care insurance.
Blancafort et al, 2021[39] (Barcelona, Spain)	Sentire-nos Be (Feeling Well) sessions are held weekly for two hours and facilitated in groups of 15 people for 12 weeks. Sessions were delivered in primary care centers or were held in public spaces for social and physical activities.	Community dwelling adults 60 years+ in disadvantaged urban areas who perceived their health as fair or poor.
Boen et al, 2012[40] (Oslo, Norway)	Weekly 3 hour group meeting 35–38 times per year with 7–10 participants. Program included (1) transportation to and from senior center, (2) a warm meal at low cost, and (3) a physical training program developed by physical therapists, run by trained volunteers.	65 years+ living at home in the community, not regular users of the senior center.
Jacobs et al, 2020[47] (California, Florida and New York, USA)	Peer-to-peer (P2P) is a minimum 1-year program matching an older adult with a trained volunteer in the same community. Volunteers provide transportation assistance, check-in calls, social activities, help with shopping, organizing services and trips to medical appointments.	65 years+, living independently in the community, at or below the poverty line, socially isolated, and who have chronic illnesses requiring frequent community resource use.
Hikichi et al, 2015[42] Hikichi et al, 2017[41] (Taketoyo, Japan)	Salons are a community project where seniors congregate and participate in social activities. Popular activities included dance classes, chatting with other participants, arts and crafts, music quizzes and games, and interactive activities with children. Seniors visited 1–3 times per month for 90–120 minutes per session. Fee of 100 yen per visit ($1USD).	All community-dwelling adults 65 years+ adults who were physically and cognitively independent in the town of Taketoyo or the participants in the Aichi Gerontological Evaluation Study.
Harada et al, 2020 [43] (Kobe City, Japan)	Tsurukabuto Active Aging Project is an events-based community program organized by Kobe University staff to create opportunities to meet and talk with neighbors and improve neighborhood social networks. Community events once per month include music, lectures about sleep and health promotion, moon viewing, academic festivals, gardening, and group walking.	60 years+, residents of the Tsurukabuto community from the electoral register in Nada Ward.
Liotta et al, 2018[46] (Rome, Italy)	The Long Live the Elderly (LLE) program includes a multi-dimensional evaluation of care needs, an individual care plan including provision of services, periodical phone calls and increased support when needed. The program intensifies when a heat wave occurs, prompting tracing by phone with staff or volunteers bringing food or medicine during home visits.	Population 75 years+ living in three urban areas in Rome.
Chapin et al, 2013[48] (Kansas, USA)	Reclaiming Joy uses dyadic relationships between volunteers and participants to guide participants through goal setting activities and to foster connections to community resources. Meetings once a week for 10 weeks.	64 years+, receiving Medicaid in three regions served by area agencies on aging, with at least one symptom of depression or anxiety.
Daban et al, 2021[44] (Barcelona, Spain)	Weekly outings in disadvantaged neighborhoods facilitated by volunteers using a portable climbing wheelchair to promote social support, group activities and participation activities such as visiting friends, walks, going to the market or attending church.	59 years+, living in isolation in their homes for two or more months due to mobility limitations and/or lack of an elevator in their buildings.
Coll-Planas et al, 2017[21] (Catalonia, Spain)	A coordinated and group-based program aimed at building and strengthening the network between primary healthcare centers, senior centers and other community assets in the neighborhood. Meetings are 1.5 hours a week for 15 weeks and includes (1) social isolation and participation discussions, (2) community assets introductions, (3) visits to community assets including primary care, and (4) arts based activities.	60 years+, community dwelling, who feel lonely "sometimes, often or always", can walk to the center independently, without cognitive decline, able to participate in group dynamic, and does not usually participate in social activities.

(Continued)

Table 3 (Continued).

Authors, Reference, Year (Location)	Intervention	Target Population
Chiang and Hsu, 2018[49] (Taichung, Taiwan)	Community Care Centers (CCC) provide health promotion, food services, home visits and telephone greetings. Home visit and telephone greetings are intended to increase social participation and linkages. CCCs are required to be set up in every neighborhood. Programs included physical activities, health knowledge courses, and leisure activities (ie arts).	All older adults living in the community.
Taylor et al, 2017[45] (Queensland, Australia)	Men's sheds provide a variety of activities including woodwork, metalwork, group social events, mentorship, and restoration projects. It is open five days a week and overseen by a management committee.	Men 65 years+, from regional or remote areas, from low socioeconomic areas.
Intervention =[Enhance] Neighborhood and Build Environment		
Park et al, 2021[67] (PyeongChang, South Korea)	Aging Study of PyeongChang Rural Area Intervention Study (ASPRA-IS) is a 24-week multi-component intervention program including home nutritional supplementation, depression management, discontinuation of high-risk medication, home hazard reduction and group exercise training.	65 years+, living in the region, living alone or receiving medical aid (government public assistance program) designated for low-income status.
Castle & Resnick, 2016[64] (Pittsburg, USA)	Staying at Home (SAH) program involves on site (1) Care Coordination, (2) Advanced Planning, (3) Medication Management, (4) Health Care Diary/ Outreach, and (5) All services paid by local health provider.	Older adults living in publicly subsidized elderly high-rise buildings.
Tohn et al, 2020[68] (Connecticut, USA)	An injury prevention intervention was added to the standard weatherization packages. An occupational therapist assessed home injury risk factors and identifies priority modifications to reduce the risk of falls over 5 visits in a year. An energy auditor accompanied the occupational therapist (OT) to improve weatherization.	70 years+ who had a slip or fall in the prior six months, from low-income households with income and eligibility for weatherization services or home energy upgrades.
Gusmano, et al, 2018[65] (New York, USA)	Self-help Active Services for Aging Model (SHASAM) provides social services provided as part of affordable housing. On-site social workers (1) assess residents for existing government programs and entitlements, (2) provide personalized functional and psychological assessments, counseling and advocacy, (3) provide health education and wellness programs, (4) lead physical activity and socialization programs, and (5) provide evaluations for a referral out to additional public services (ie chronic disease programs or in-home safety technology).	65 years+, who live in affordable housing buildings, and who are Medicare beneficiaries.
Callaghan et al, 2017[69] (England, UK)	Shared Lives (SL) is a service where an adult who needs support or accommodation moves into (or regularly visits) the home of an approved SL carer.	65 years+ people with learning disabilities, using any form of SL support with capacity for consent.
Turcotte et al, 2019[66] (Massachusetts, USA)	Community health worker assessment followed by an individualized intervention plan. Home visits consisting of (1) environment mediations such as pest management, mattress encasements, cleaning supplies, and structural interventions like repairing ventilation or plumbing, and (2) culturally and literacy appropriate education.	62 years+ adults with, low-income, diagnosed with asthma by a physician, residing in public and private subsidized housing.
Intervention = [Improving] Navigation of Health and Social Services		
Galbraith et al, 2017[50] Balaban et al, 2015[51] (Massachusetts, USA)	Patient navigators (PNs) conduct introductory visit(s) with the patient and caregivers, then weekly telephone meetings. PNs (1) organize appointments and rescheduling, (2) address barriers to obtaining or taking medications, (3) identify concerning symptoms and facilitate communication with MD offices, (4) assist with transportation, (5) reassess patients' home care needs and make connections to community services, (6) assist with health insurance issues, and support patient self-management, and (7) help patients navigate the health care system.	General medicine inpatients having at least one of the following readmission risk factors: (1) age ≥60 years, (2) any inpatient admission within the past 6 months, (3) length of stay ≥3 days, (4) admission diagnosis of heart failure, or (5) chronic obstructive pulmonary disease.

(*Continued*)

Table 3 (Continued).

Authors, Reference, Year (Location)	Intervention	Target Population
Evans et al, 2021[54] (Chicago, USA)	The Chicago Southland Coalition for Transition Care program (CSCTC) is a social worker driven care transition program to coordinate post hospital care. Following the Coleman Care Transition Intervention (CTI) model, it (1) manages health care, meds, and nutrition, (2) communicates more effectively with physicians, and (3) connects to community resources such as meal delivery, payment assistance for meds and transportation. CSCTC supplies patients with pharmacy free support services and home-delivered meals.	Four hospitals that serviced 70 low-income zip codes in Chicago Southland area.
Prior et al, 2012[63] (Midwestern, USA)	A faith based, grant funded, community senior outreach program focused on assisting clients towards stabilization of crisis situations and the development of a plan for ongoing social interventions. Clients receive weekly in-home visits for the first 2 to 3 months and biweekly to monthly visits thereafter depending on need. Emphasis placed on utilization of community resources, development of self-management skills, resolution or reduction of in financial concerns and connection with social and family supports. Program monies are utilized to assist with prescription costs, housing, and transportation needs when no other resources are available.	55 years+, with histories of repeated emergency department or hospital visits, who are part of the senior outreach program (usually seniors with< $1000 per month, 1/3 live in subsidized housing).
Scharlach et al, 2015[52] (San Diego, USA)	ElderHelp Concierge Club is a volunteer run membership program. Members receive an assessment for services eligibility which includes: (1) driving, (2) grocery shopping, (3) housekeeping, (4) home maintenance and repair, (5) financial advocacy, (6) friendly visits, (7) and pet care. Dues follow a capitated model and are dependent on income and home ownership.	60 years+, who do not have a condition that would prevent them from participating fully in their own care.
Stevens et al, 2015[55] (Texas, USA)	The community living program (CLP) includes (1) plan of care based on formal assessment, (2) health coaching, (3) money for purchasing formal care ($750/month), and (4) home visits and telephone calls. 6 home visits and 3 telephone calls over 10 months.	60 years+, a resident of central Texas Agency in Aging service area, functionally impaired, memory or health problems that make it difficult to live alone, and availability of informal support system.
Watkins et al, 2012[56] (Southeastern USA)	Hospital to Home Program involves a elder navigator who identifies eligible participants during hospital admission, arranges social supports to begin immediately after discharge, and home visits within 72 hours of discharge. The navigator reviews orders and medications, confirms services and helps the patient and family identify other needs. Services including transportation, light housekeeping, laundry, meal preparation, prescription pick up and grocery shopping were provided at no cost to the patient up to 4 months.	65+, eligible for Medicare ± Medicaid, with chronic conditions, physical disability or functional decline requiring assistance with function, falls, polypharmacy, cognitive decline or depression, nutritional impairment, hip fracture, and limited social support.
Szanton et al, 2011, 2015, 2016, and 2019[57–60] Crews et al, 2019[61] (Maryland, USA) Spoelstra et al, 2019[62] (Michigan, USA)	Community Aging in Place: Advancing Better Living for Elders (CAPABLE) CAPABLE involves ~ 10 in-home sessions, each 60 minutes long, over a 6-month period (depends on paper). It draws upon best practices to enhance uptake and adoption of intervention strategies such as patient-centered care and motivational interviewing. All participants in the intervention received each component of the intervention (assessment, education, interactive identification of barriers to function with joint discussion of possible retraining and solutions), but interventionists customized components to each participant's risk profile and goals. Includes up to $1300 USD for repairs.	65 years+, cognitively intact, difficulty with at least 1 Activity of Daily Living (ADL) or 2 instrumental ADLs, income <200% of federal poverty line.
Intervention = [Promoting] Education		
Suominen et al, 2015[75] (Helsinki, Finland)	One year intervention with tailored nutritional guidance with home visits, and discussions with the participants and their caregivers every three months with 1–2 group sessions The nutritionist visited each couple between four and eight times according to the participants' individual needs.	A 65 years+ person with dementia living with spouse, able to reach the study place by taxi and stand on a scale, living in the Helsinki metropolitan area, without terminal disease.

(Continued)

Table 3 (Continued).

Authors, Reference, Year (Location)	Intervention	Target Population
Jo et al, 2018[73] (Ontario, Canada)	Canada Enoch Senior's College (CESC) runs weekly sessions for a duration of 8–11 weeks biannually. Each day is divided into four time slots. The morning is an organized assembly with short lectures on Korean-relevant topics. Lunch is a traditional Korean style congregate meal. Afternoons are elective classes and small groups (arts, music, technology, medicine, etc.).	Korean immigrant older adults in the Greater Toronto Area.
Molina-Luque et al, 2018[74] (Catalonia, Spain)	Senior Programme of the University of Lieda is a four year program. Senior students choose a field of study that puts into practice their previous knowledge. These students also participate in extra-curricular programs on social innovation for ageing and "together old and young" (TOY) program.	>55 years
Intervention = [Help with] Economic Stability		
Aguila & Smith, 2020[70] Aguila et al, 2015[71] (Yucatan, Mexico)	Reconocer Urbano is a supplementary income program providing a monthly supplement of MXN$550 for 18 months.	All 70 years+ residents who are eligible for supplemental income programs.
Herity et al, 2018 (North Carolina, USA)	Senior PharmAssist optimizes medication management while addressing social determinants. Scheduled meetings occur every 6 months. Meetings with pharmacists for (1) medication therapy management, (2) education, (3) medication copayment assistance, (4) Medicare insurance counseling, and (5) referral to other services. Program flexible (open 40h/week) or provides home visits.	60 years+, Medicare-eligible, have an income of 200% of the federal poverty level or less.

Effects of Interventions

Following quality appraisal, data was synthesized according to intervention category and outcome type (individual results in Supplement E). A visual summary of effect direction by vote counting of all included studies has been tabulated in Table 4. Across all studies, there was a positive direction of effect for function, cognition (borderline), subjective health and decreased hospital use. The sign test for the effect on non-hospital physician or nurse visits was 1, signalling interventions were equally likely to result in increased or decreased healthcare use.

Mortality

Only one study examined mortality as an outcome in relation to a social intervention. The Long Live the Elderly (LLE) study demonstrated a 13% reduction in mortality (p<0.001) during the summer of 2015 in urban areas with LLE compared to areas without the program, with indirect evidence to also suggest LLE attenuated the pre-existing association of higher mortality and lower socioeconomic status.[46]

Function

Of the 10 studies, 9 used a measure for ADLs or IADLs;[42,43,52,57–59,61,62,67,70] all but two had a positive direction of effect.[52,59] Across 8 studies with a comparison group, the combined one-sided p value was <0.001, suggesting a positive effect on function favouring the intervention in at least one study. The studies reporting outcomes with calculable mean differences are visualized in Figure 3A with small estimated effect sizes (less than a 0.2 point difference in any measure used). The study of highest quality and design in this review examined the CAPABLE intervention. At its primary endpoint of 5 months, there was a medium improvement in the CAPABLE group's ADL (aOR: 0.70, CI: 0.54–0.93, p=0.01) and IADL scores (aOR: 0.83, CI: 0.65–1.06, p=0.13) but not at 12 months (secondary endpoint).[59]

Table 4 Summary of Direction of Health Impacts from Included Studies Using Vote Counting

Author, Year	Study Design	MMAT Score	Sample (I/C)	Follow Up Time	Mortality	Function	Cognition	Subjective Health	Hospital Use	Other Healthcare Use
Intervention = Social and Community Context										
Bae et al, 2019	RCT	80%	41/83	6 months[a]			◁▷			
Blancafort et al, 2021	RCT	60%	195/195	12 weeks – 9 months[b]				◁▷	Δ	◁▷
Boen et al, 2012	RCT	0%	77/61	12 months[a]				▽		
Jacobs et al, 2020	CBA	100%	222/234	3–12 months					◁▷	
Hikichi et al, 2015 and 2017	CBA	80%	1067/13,195(cognition) 246/2175 (function)	5–7 years[a]		▲	▲			
Harada et al, 2020	CBA	60%	173/489	3 years[a]		Δ		Δ		
Liotta et al, 2018	RCS	80%	6483/5724	~1.5 years	▲					
Chapin et al, 2013	UBA	80%	40	90days[b]				Δ		
Daban et al, 2021	UBA	80%	147	6 months[a]				▲		
Coll-Planas et al, 2017	UBA	60%	36	15 weeks				Δ	□	▽
Chiang et al, 2018	XUS	60%	417	n.a			Δ	Δ		
Taylor et al, 2017	MM/ XUS	40%	143	n.a				▽		
Navigation of Health and Social Services										
Galbraith et al, 2017 and Balaban et al, 2015	RCT	40%	747/1190	180 days[a]					Δ	◁▷
Evans et al, 2021	RCS	100%	45,522/ 127,443	7–90 days[a]					▲	
Prior et al, 2012	UBA	80%	193	24 months[b]					▲	
Scharlach et al, 2015	UBA	80%	26	6 months[a]		▽		Δ	Δ	
Stevens et al, 2015	UBA	40%	149	12 months[a]			Δ	Δ	▲	▲
Watkins et al, 2012	UBA	40%	292	30 days - 4 months[b]				▲	Δ	
Intervention = CAPABLE or variation (Navigation of Health and Social Services)										
Szanton et al, 2019	RCT	100%	152/148	5–12 months[b]		Δ ◁▷				
Szanton et al, 2011	RCT	60%	24/16	6 months[b]		Δ		Δ		
Crews et al, 2019	RCT	60%	6/6	5 months[b]		Δ				
Spoelstra et al, 2018	CBA	60%	270/1350	32 weeks[a]		Δ			◁▷	
Szanton et al, 2015 and 2016	UBA	80%	281	5 months[a]		Δ				

(*Continued*)

Table 4 (Continued).

Author, Year	Study Design	MMAT Score	Sample (I/C)	Follow Up Time	Mortality	Function	Cognition	Subjective Health	Hospital Use	Other Healthcare Use
Intervention = Neighbourhood and Built Environment										
Park et al, 2021	CBA	80%	187/196	3–30 months[a]		Δ				
Castle et al, 2016	CBA	40%	736/399	6months − 3 years[a]				▲	▲	▼
Tohn et al, 2020	CBA	40%	49/35	6 months[b]					Δ	
Gusmano et al, 2018	RCS	60%	1248/15,947	1 year[a]					▲	
Callaghan et al, 2017	XCS	100%	121/121	n.d				▲		
Turcotte et al, 2019	UBA	60%	93	12 months[a]				▲	Δ	▲
Intervention = Education										
Suominen et al, 2015	RCT	60%	50/49	12 months[a]				▲		
Jo et al, 2018	MM/ UBA	80%	79	8–11 weeks				Δ		
Molina-Luque et al, 2018	Q	20%	6	4 years			Δ			
Intervention = Economic Stability										
Agulia et al, 2015, 2020	RCT	80%	1146/510	6–18 months[a]		▲	▲			▽
Herity et al, 2018	RU	60%	191	6–24 months[a]				▲	Δ	
Vote Counting using Sign Test										
Votes showing benefit/Votes showing harm/Votes with mixed results					1/0/0	8/1/1	5/0/1	15/2/1	12/0/3	2/3/2
Two sided sign test					n.a.	**0.039**	0.06	**0.002**	**<0.001**	1.00

Notes: Effect direction: upward arrow (Δ▲) = positive health impact or reduction in health service use, downward arrow (▽▼) = negative health impact or increase in health service use, sideways arrow (◁► or ◄▷) =mixed effects/ conflicting findings as multiple outcome measures, square (□) = results not displayed and text states no difference in effect. Synthesis of multiple outcomes within same outcome domain: report direction (positive or negative) when combined outcomes >70% in same direction, report mixed effects when combined outcomes <70% consistency in one direction. Statistical significance: filled arrow = met statistical significance, empty arrow = did not met statistical significance at p<0.05. Synthesis of statistical significance of multiple outcomes within same outcome domain: report as statistically significant >60% of outcomes statistically significant, report as not met statistical significance if <60% of outcomes statistically significant. Statistical tests reported according to following hierarchy depending on availability: Controlled studies: differences between control and intervention group at follow up > changes within intervention group only at follow up. Uncontrolled studies: change since baseline
Follow up: [a]Time from start of intervention, [b]Time from end of intervention.
Abbreviations: n.a., not applicable; n.d., not described; Study design: RCT, randomized controlled trial (includes cluster, parallel and waitlist); CBA, controlled before and after study; RCS, retrospective controlled study; XCS, cross-sectional controlled study; UBA, uncontrolled before and after study; RU, retrospective uncontrolled study; XUS, cross-sectional uncontrolled study; MM, mixed methods; Q, primary qualitative study; MMAT, Mixed Methods Appraisal Tool.
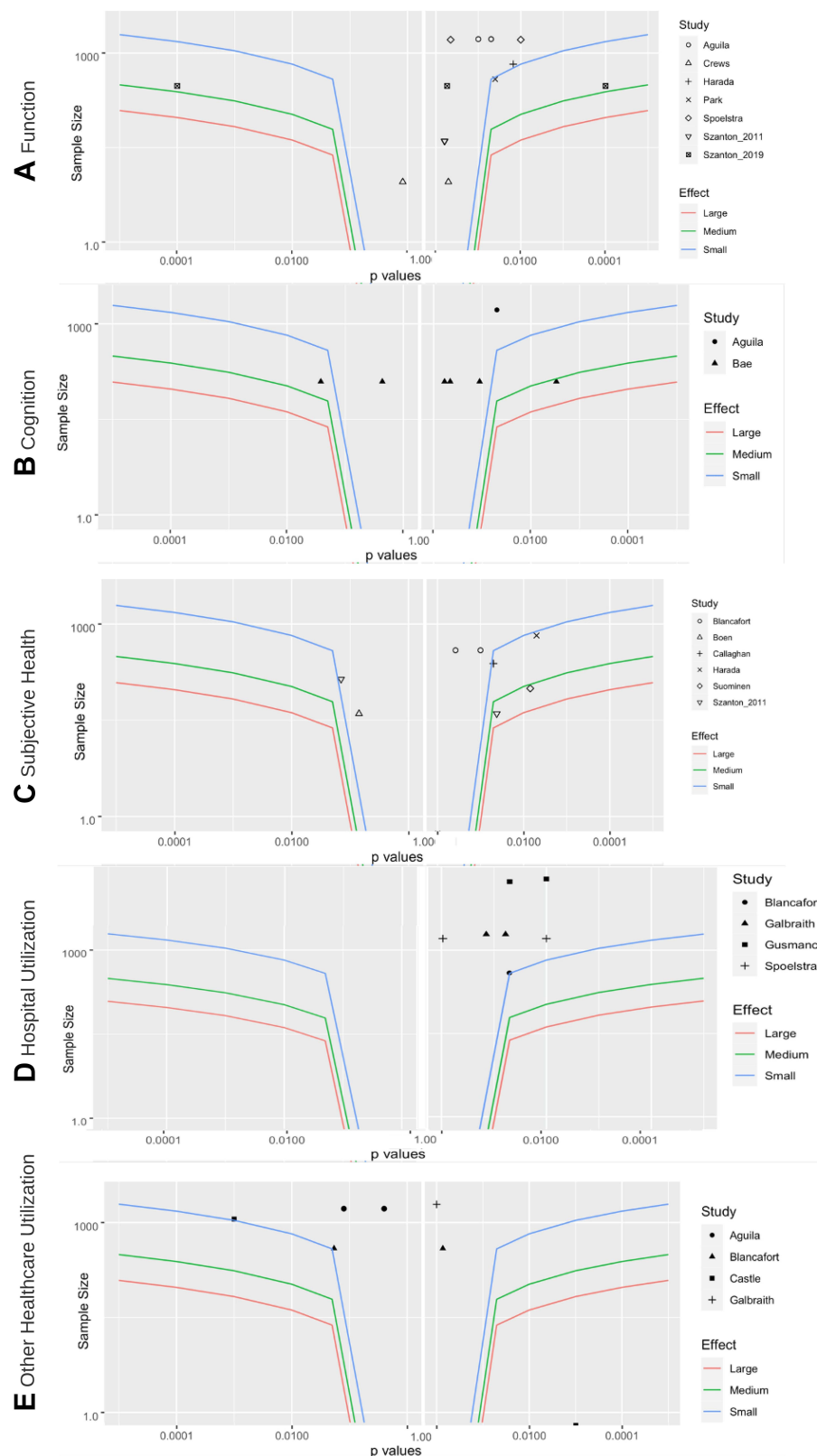
Figure 3 Albatross plots depicting the association between interventions and five health outcomes (**A** – function, **B** – cognition, **C** – subjective health, **D** – hospital utilization, **E** – other healthcare utilization). Effect size contours represent mean differences of 0.2 (small), 0.5 (medium) and 0.8 (large). The left wings represent a negative association, the right wings represent a positive association and a p value of 1.00 represents a null effect.

Cognition

Five out of 6 studies demonstrated benefit on cognition as an outcome of interest.[41,49,55,70,74] Three of the interventions focused on strengthening social and community participation.[38,41,49] Of the studies with a control group, there was strong evidence of cognitive benefit in at least one study using eight distinct measures of cognition (p<0.001, 3 studies). One RCT reported mixed results with statistically significant benefits on spatial memory only out of 6 cognitive measures.[38] Another demonstrated improved verbal recall in the intervention group at 6 and 12 months.[70] The estimated effect sizes from the two RCTs are presented in Figure 3B.

Subjective Health

Subjective health (self-perceived or self-reported) or health related quality of life was the most commonly evaluated outcome in 18 studies;[21,39,40,43–45,48,49,52,55,56,60,64,66,69,72,73,75] but was also the outcome with the highest proportion of uncontrolled studies. Notably, at least half of all studies in each intervention category measured subjective health. Combining the p values from the controlled studies suggest we reject the null hypothesis of no benefit in any study (p<0.001, 7 studies). The Albatross plot is depicted in Figure 3C and the estimated average effect size ranges from a small to medium improvement in subjective health.

Hospital Utilization

ED visits or hospitalizations were assessed in 15 studies; 80% reported reduced hospital use.[39,50,52,54–56,63–66,68,72] Combining p values implies strong evidence (p<0.001, 8 studies) of positive effect on reducing hospital use but Figure 3D suggests any size of effect would be small.

Other Healthcare Utilization

Three studies reported increased primary care provider visits[21,64,70] and two studies reported decreased visits[55,66] although the latter were both uncontrolled before after (UBA) studies of low quality. Within studies, this outcome varied as well; for example, in one study the intervention decreased physician visits but increased nursing visits.[39] The calculated combined p value of 4 controlled studies was 0.98 (accepting the null of no benefit of social interventions collectively on primary care provider visits), reflected in Figure 3E.

Discussion
Summary of Results

By counting direction of effect in all studies, the authors show there is a signal for effectiveness on function, subjective health and hospital utilization outcomes greater than chance alone for complex interventions with a main component of the intervention targeting social vulnerability. Then, combining p values of studies with a control group provided strong evidence (p<0.001) that at least one of the interventions improved function, cognition, subjective health and hospital utilization in a positive direction, although the effect sizes estimated with the Albatross plots were small (possible exception of a medium effect size for subjective health). There was an inadequate number of studies evaluating death as an outcome, but the sole study showed a statistically significant reduction in mortality. There is no evidence to suggest the interventions in this review had a consistent impact on primary care utilization. Although a positive effect was coded as a reduction in healthcare utilization, increasing physician and nursing visits can be seen as a good outcome in certain circumstances (ie for older adults in need but with reduced access) and should be considered in the interpretation of results. The complex interventions also demonstrated substantial variations in the program components, settings within the community and targeted older adult population. This review aligns with a recent systematic review and meta-analysis also addressing the gap between social interventions and measuring objective health outcomes, which concluded governmental social policies are an overall promising way to improve population health but noted that studies are often underpowered to detect a health effect, which offers an explanation for the small or null associations found by this review.[76]

Strengths & Limitations

This review is novel in that it has attempted to describe, and synthesize, complex interventions where the common thread is a strong focus on social interventions. This review looks at effectiveness on objective health outcomes, as opposed to the more common health outcomes of self-perceived improvements, lifestyle changes or surrogate markers (ie increased physical activity);[15] albeit, the measured outcomes may not reflect those that are most valued by older adults. By including all types of studies, we are able to determine, in principle, that complex interventions focusing on reducing social vulnerability as a key intervention component does improve health outcomes. However, the choice to lump interventions instead of splitting the complex interventions means that the question of which type of intervention, for which populations, or which components of the intervention are most effective remains unanswerable. For example, Cappelli et al's recent review on social vulnerability suggested the quality of social relationship was a key factor in protecting older adults from functional decline.[77] Future research could answer this latter question using component network meta-analytic methods as recommended by the Cochrane Collaboration.

The biggest challenge of this review was managing the heterogeneity of the targeted populations, the SDOH addressed, and the measurement of health outcomes; hence synthesis via a meta-analysis was not feasible nor was answering questions of effect size and relative weights of each study according to quality. Generalizing across studies is also problematic given that 12 different countries and 34 distinct complex interventions, each with multiple components, are included in the findings. How much an intervention can impact is influenced by national or regional health and social policies. For example, the North American navigator interventions may not be as effective in Japan where older adults are automatically assessed for community resources under the national long-term care insurance scheme. Since the same intervention will have varied effects in different populations when the distributions of SDOH supports differ, there is a practical benefit of including all study types in this review, not only the ones with the best evidence or the most funding for a robust study design. Even if only RCTs were examined, the gold standard's emphasis on "average effects" would not solve the problem of generalizability, nor would it help policymakers implement an intervention in their specific context. Said another way, the authors recognize that complexities create less definitive causal inferences which is a limitation of the review, but continue to search for methods to answer these types of questions without artificially fragmenting the duality of medical and social frailty.

The authors also recognize that this is a synthesis of social interventions that targeted reductions in social vulnerabilities through the social determinants. However, this is not the same as assuming the participants of the included studies were at the same level of baseline social vulnerability, which is another study limitation. A review of this nature, looking at interventions for a defined population with known social disadvantages would be a worthy endeavor.

While this review followed rigorous PRISMA-CI methodology, a single reviewer conducted the screening, data extraction and analysis as part of her doctoral studies. Ideally, a double screening and extraction approach would have been carried out to increase internal validity and reliability, and reduce the chance of random error or personal bias. However, since there was significant consultation between the authors to ensure adherence to the pre-established review protocol and to ensure consensus for any difficult screening questions, it is unlikely that double screening would change the overall findings of this paper.

Clinical, Research and Policy Relevance

Investing in social interventions to improve health has strong intuitive appeal, fundamentally based on the assumption that better population health requires interventions for socially vulnerable older adults. The question of how effective SV interventions may be remains difficult to answer with this review providing a small, but certain positive signal of effect among 34 complex interventions with a strong social focus. Furthermore, the findings of this review challenge researchers in this area to develop or revitalise research methodologies that can make cohesive sense of the heterogeneity of these studies, of the pragmatic nature of social interventions and of the wide variety populations. By providing evidence for the collective effectiveness and practicability of such interventions, there are implications for clinicians, policymakers and older adults themselves to implement and advocate for social interventions that will benefit their communities with objective health improvements as a motivator.

Conclusion

Attention to reducing an older adult's social vulnerability may be helpful in accomplishing improvements to health. Complex interventions with a main component of the intervention targeting social vulnerability showed evidence of positive effects on function, cognition, subjective health and reduced hospital utilization. Moreover, this review demonstrates heterogeneity in intervention type and quality of studies and supports the need for more research in this area.

Abbreviations

aOR, adjusted odds ratio; CBA, controlled before & after study; CDC, Centers for Disease Control and Prevention; CI, confidence interval EPPI, Evidence for Policy and Practice Information and Co-ordination Centre; MMAT, Mixed Methods Appraisal Tool; OT, occupational therapist; PICOT population, intervention, comparison, outcome, type of study; PRESS, Peer Review Electronic Search Strategies; Q, qualitative; QoL, quality of life; RCS, retrospective controlled study; RCT, randomized controlled trial; RU, retrospective uncontrolled study; SDOH, social determinants of health; SV, social vulnerability; TRoPHI, Trials Registrar of Promoting Health Interventions; UBA, uncontrolled before after study; USA, United States of America; WHO, World Health Organization; XCS, cross-sectional controlled study; XUS, cross sectional uncontrolled study.

Author's Information

This work is a modified and shortened version of the primary author's comprehensive exams written as part of her doctoral program.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

KR is President and Chief Science Officer of DGI Clinical, which in the last five years has contracts with pharma and device manufacturers on individualized outcome measurement. In 2017 he attended an advisory board meeting with Lundbeck. Otherwise any personal fees are for invited guest lectures and academic symposia, received directly from event organizers, chiefly for presentations on frailty. He is Associate Director of the Canadian Consortium on Neurodegeneration in Aging, which is funded by the Canadian Institutes of Health Research, and with additional funding from the Alzheimer Society of Canada and several other charities, as well as, in its first phase (2013–2018), from Pfizer Canada and Sanofi Canada. He receives career support from the Dalhousie Medical Research Foundation as the Kathryn

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