



ROSA Research  
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**A CAUSAL DISCOVERY  
EXPLORATION OF DETERMINANTS  
OF SOCIAL ISOLATION**

# **A causal discovery exploration of determinants of social isolation**

## **Summary of key findings and recommendations**

### ***Key findings***

#### **1. Causal discovery and inference as data-driven approach to social isolation**

Empirical literature has spawned different theories of social isolation, but we propose that such theoretical approach may not be able to capture the complexity and nuances of its determinants. Therefore, we adopt a data driven exploratory method to produce a framework of the determinants of social isolation. This produced a model of the potential determinants of social isolation that could be targeted for additional study by researchers and policymakers.

#### **2. Perceived helpfulness and perceived social isolation**

Perceived helpfulness formed a direct causal relationship with social isolation. A sense of meaning contributes directly to feelings of helpfulness, which in turn forms a direct causal link to social isolation. Additionally, physical health is likely to be a pre-requisite for a sense of meaning, which then forms indirect links to social isolation. Promoting activities that enhance both health and helpfulness may effectively reduce social isolation in older adults.

#### **3. Loneliness precedes social isolation**

Our results suggest that perceived isolation and loneliness may be distinct concepts among older adults in Singapore, with loneliness more likely to precede social isolation. This finding from a data driven approach shows that this direction differs from other frameworks that suggest a bidirectional relationship between social isolation and loneliness.

### ***Policy implications***

#### **Multifaceted interventions to reduce social isolation**

The relationship where a sense of helpfulness is likely to reduce social isolation is crucial for policymakers. To address this gap, promoting helpfulness through diverse programs like volunteerism and aligning with different campaigns of health or mental health may enhance older adults' well-being and diminish social isolation. However, such initiatives may need to target older adults' sense of helpfulness and meaning, and to promote health as an enabler of such sentiments which could reduce social isolation.

## INTRODUCTION

Social isolation (defined as the lack of social integration) among older adults poses significant health risks such as reduced longevity, increased risk of stroke, depression, dementia, and loss of cognitive functioning (Ng et al., 2020; Donovan & Blazer, 2020). Hence, the prevalence of social isolation among older adults in Singapore could hinder healthy longevity (National Institute on Aging, 2020). Evidently, theoretical frameworks of social isolation processes are complex and vary among different populations (Shankar et al., 2017; Kutoane et al., 2021). Local studies have acknowledged the influence of population shifts, changes in family structures, and economic factors on social isolation (Straughan et al., 2020; Ge et al., 2022). Engaging in behaviours like volunteering may motivate older adults to connect with others, which may result in a sense of helpfulness or purpose and reduce their sense of social isolation (Hoang et al., 2022). Therefore, this brief reports on potential causes of social isolation such as feelings of helpfulness. Our study proposes a novel method of causal discovery, providing a data driven framework to describe potential causes of social isolation. This can inform policymakers in crafting effective measures to foster integration and mitigate its prevalence, promoting healthy aging.

### **Social isolation and wellbeing**

Studies have broadly identified life domains of wellbeing that are known to contribute to social isolation; these include health, mental health, economic, and social wellbeing (e.g., life satisfaction etc.) (Zavaleta, Samuel & Mills, 2017; Stiglitz, Sen & Fitoussi, 2009). Poor mental health for instance is known to be associated with social isolation (Cain et al., 2018), which may exacerbate the absence of social connections and reduce overall mood (Milman et al., 2022). This hindrance to meaningful relationships not only limits opportunities for social interaction but also correlates with poor health and other unhealthy lifestyle habits (Sakurai et al., 2019). Furthermore, social isolation may impact economic well-being by limiting job opportunities, reducing productivity, and elevating the risk of poverty, hindering access to employment and networking opportunities (Kasinitz & Rosenberg, 1996). This suggests that social isolation can have a negative impact across several well-being domains.

### **Theories of social isolation**

Studies have indicated that social isolation among older adults is associated with unemployment, lower education levels, living alone, and widowed or divorced marital status (Asante & Tuffour, 2022; Donovan & Blazer, 2020; Ge et al., 2017; Sandu, Zólyomi & Leichsenring, 2021). Theoretical frameworks of social isolation often include loneliness due to conceptual similarities and similar health outcomes (Machielse, 2017; Hodgson et al., 2020; Barnes et al., 2022). However, relying solely on conceptual models may not be sufficient to

identify potential causes of social isolation. These models identify factors that ought to be implicated, but the direction of influence may flow both ways (Hodgson et al., 2020; Barnes et al., 2022). For example, Hodgson et al. (2020) presented a model where social isolation and loneliness may influence each other. Psychological factors like mood and cognitive decline, and individual sociological factors like health literacy may also form a bidirectional relationship with loneliness and social isolation. Relying on conceptual models may therefore leave open the question of causality, positing mutual influence without sufficiently testing these relations. Existing theories may also be constrained by specific locations and contexts, which may lack generalizability (Klingenberg, 2002), and under specify the multifaceted nature of social isolation (Friedman et al., 2022). Furthermore, theory-driven approaches might overlook nuanced connections, hindering the detection of subtleties beyond theoretical bounds (Petersen et al., 2023). This limitation hampers the emergence of novel findings that could enrich literature.

We therefore propose to adopt a novel method of causal discovery approach, to uncover connections that may be overlooked by existing theories. This data-driven method allows us to understand potential causes of social isolation by simulating interventions to assess how changes in one factor impact another. Our brief seeks to test the plausible causal relationship of social isolation, which enables an examination of possible determinants that may be overlooked by the theoretical literature. Causal discovery also allows for simulated interventions, which could highlight promising avenues for further research. This would help policymakers and social scientists to decide on the type of research efforts on social isolation that deserve more investment and support.

## **STUDY**

In this research brief, we take an exploratory approach to examine the potential causes of social isolation with four domains of wellbeing. Existing literature has spawned theories of social isolation, but theory driven approaches may overlook potential connections, and may mis-identify the directional relationships between wellbeing and social isolation. Causal inference also allows for simulated interventions, which are useful for practices and policy makers. Based on existing research, we have identified several potential causal factors, which we categorized into various groups of well-being factors. Using a novel collaborative framework utilised computer science methodology and social science theory, we aim to achieve the following:

1. Conduct a data driven process to tease out a better model that would allow us to identify direct and indirect associations of between social isolation and wellbeing among older adults in Singapore with more detail and specificity.
2. Use causal inference to simulate interventions on social isolation to demonstrate the applicability of the model for policy recommendations.

## **METHOD**

### **Causal discovery and inference**

We utilised a collaborative framework incorporating causal discovery, causal inference, and knowledge from domain experts. Causal discovery takes an exploratory approach, which identifies interrelationships between factors, along with estimating their direct and indirect relationships with each other. Experts from ROSA were engaged in the assessment of critical variables relevant to social isolation. These variables encompass detailed metrics related to health, mental health, economic and social wellbeing. For this brief, we utilised TETRAD software (Ramsey et. al., 2018) to assist the causal discovery process, specifically by applying the Best Order Score Search (BOSS) (Andrews et. al., 2023) for inferring the initial causal graph from SLP data. This process would create a causal graph, which is a visual representation of the direction of influence among these variables.

From this causal graph, we calculated the regression coefficients for the paths between these variables. Furthermore, we utilized DoWhy (Sharma et. al., 2020; Blöbaum et. al., 2022), a Python library developed to assist causal inference. It comprises broad functionalities based on structural equation modelling (SEM), including simulating randomized control trials, and estimating how a change in one variable directly or indirectly leads to another change while adjusting for confounds in the model. This meant that using the framework of structural equation modelling (SEM), it is possible to hypothetically simulate the effect of an intervention, either directly or indirectly, on social isolation within the model. We utilised both domain expert knowledge and empirical data to determine pathways that we can use to simulate an intervention.

### **Participants**

All participants were derived from the Singapore Life Panel (see Vaithianathan et al., 2021) and a total of 8013 respondents were included. All participants were extracted from Wave 94 (May 2023), with a mean age of 64 years (SD=7.4). The average monthly household income (inclusive of income from work, family and friends and other sources) was SGD5339.07 (SD=6045.44). The respondent gender composition consists of 43.9% males and 50.9% females, with 5.2% of respondents not indicating their gender. When asked for

their ethnicity, the respondent ethnicity composition were 74.8% Chinese, 4.2% Malays, 4.3% Indians and 1.5% other ethnicities, with 15.3% of respondents not inputting their ethnicity. Regarding the respondents' highest educational level reached, 35.0% reported attaining secondary school education, 30.7% reported having post-secondary education, and 3.6% reported having no formal education.

## **Materials**

**Social isolation.** This measure is on one's perception of social isolation using an item "How often do you feel isolated from others?", with a 5-point scale from 1=None of the time to 5=All the time.

**Feeling helpful.** This measure is on one's perception of feeling helpful to other people using an item "How often do you feel that you are helpful to friends or family?", with a 5-point scale from 1=None of the time to 5=All the time.

**Feeling lonely.** Participants were asked if they felt lonely over the past week, on a 6-Point scale (1=All of the time to 6=None of the time).

**Meaning.** This measure is on one's sense of meaning and purpose in life using an item "Over the past month, how often did you experience a sense of meaning and purpose in your life?", with a 6-point scale from 1 = All the time to 6= None of the time.

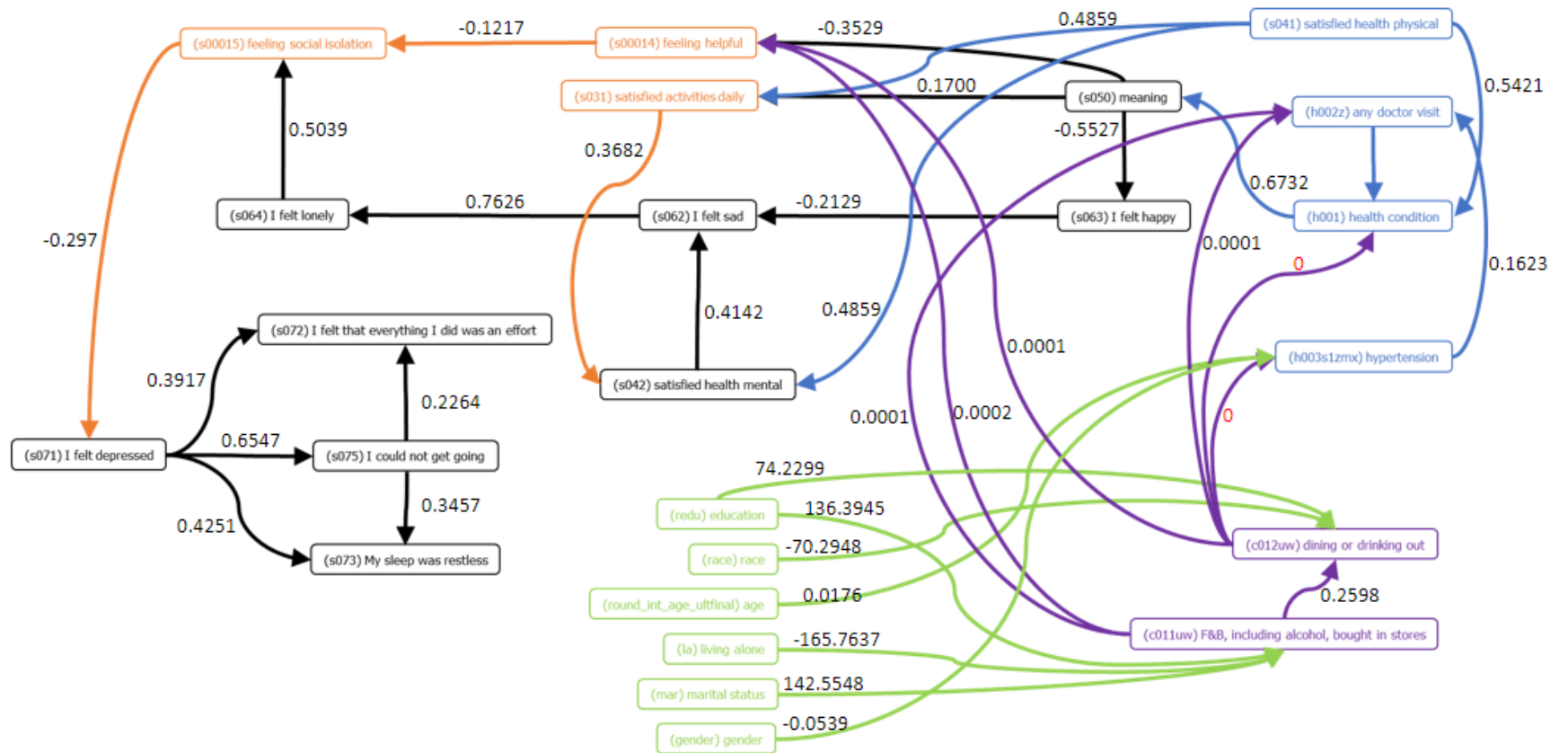
## **RESULTS**

### **Multi-faceted causes of social isolation**

We conducted causal discovery and inference analysis by first including 93 demographic and wellbeing indicators. The algorithm distils these into indicators that are most relevant to social isolation, resulting in a total of 24 variables. We further estimated the regression coefficients for each direct path in the model.

**Figure 1**

*Causal relationships between indicators of wellbeing and social isolation along with their regression coefficients*



In Figure 1, the green boxes represent demographic variables, blue boxes represent health indicators, purple boxes represent social activities, orange boxes represent social wellbeing indicators and black boxes represent mental wellbeing indicators. The arrows represent causal relationships between variables that the model has established with high confidence and the numbers beside each arrow indicate the regression coefficient of each identified relationship. There are only two direct paths to social isolation, where ‘feeling helpful’ and ‘feeling lonely’ are likely to have a direct causal effect on social isolation. Coefficient paths from ‘dining or drinking out’ to ‘health conditions and ‘hypertension’ however were not significant in the model. ‘Meaning’ formed a direct path with ‘feeling helpful’, with negative coefficients due to its reverse scoring.

### Simulating interventions for social isolation

We simulated interventions for ‘meaning’ and ‘feeling helpful’. When simulations were applied, a one-point increase in ‘feeling helpful’ resulted in a reduction of social isolation by 0.257 points. A two-point increase in ‘feeling helpful’ resulted in a reduction of 0.344 points for social isolation. We further simulated interventions for both ‘feeling helpful’ and ‘meaning’. A one point-increase for each variable led to a reduction of 0.209 for social isolation, and a two-point increase reduced social isolation by 0.344 points (Table 1).

**Table 1**

*The simulated effect of meaning and feeling helpful on social isolation.*

Pathway		Decrease in social isolation when each variable in the pathway is increase by	
		<u>1 Point</u>	<u>2 Points</u>
1	Feeling helpful	0.157	0.275
2	Meaning -> Feeling helpful	0.209	0.344

*Note.* Mean of social isolation before intervention is 2.039.

## DISCUSSION

In this research brief, we have utilised exploratory methods on cross-sectional data of older adults to examine the potential causes of social isolation using four indicators of wellbeing. One key finding is that feeling helpful may form a direct path to social isolation. Another important finding is that feeling lonely may precedes feelings of perceived social isolation. Health



characteristics however form an indirect path toward social isolation, through perceived meaning and helpfulness. Based on our model, we identified several potential pathways that should elucidate a hypothetical effect of an intervention on social isolation. This means that if an intervention were able to positively affect any of these variables in these paths, this is likely to reduce older adults' sense of social isolation. This potentially renders the model useful for policy makers to understand how changes in different facets of wellbeing would impact social isolation.

### **Causal relationship between perceived helpfulness and perceived social isolation**

We found an inferred causal relationship between perceived helpfulness and perceived social isolation among older adults in Singapore. This implies that hypothetically increasing feelings of helpfulness would likely cause reduced perceptions of social isolation. We also found that having a sense of meaning or purpose may contribute to feelings of helpfulness, and this in turn could contribute to lower social isolation. Moreover, good physical health is likely a prerequisite to having a sense of meaning and perceived helpfulness, which in turn could contribute to lower social isolation. Hence, activities that encourage older adults to stay healthy and perform helpful acts would likely contribute to lower social isolation.

In wider literature, perceived helpfulness is broadly linked to better mental health outcomes (Cain et al., 2018). Similarly, perceived meaning has been shown to decrease social isolation through enhanced social connections (Milman et al., 2022). Therefore, we propose that researchers could expand their conceptualization of social isolation, to include self-perceived feelings of helpfulness and meaning in their theoretical frameworks. Increasing a sense of meaning in life may prompt older adults to engage in altruistic behaviours, leading to reduced social isolation. However, contrary to some frameworks (Hodgson et al., 2020), we found that subjective factors like feeling helpful or loneliness are more likely to have a closer relationship with social isolation compared with health and economic factors.

### **Perceived social isolation and perceived loneliness**

Our results show that feelings of loneliness are likely to precede feeling socially isolated. This may be at odds with frameworks that presuppose a bidirectional relationship (Hodgson et al., 2020; Barnes et al., 2022). These authors, however, define social isolation as an objective measure, but others have cited this as a subjective or an objective indicator (Fiordelli, Guggiari, Schulz & Petrocchi, 2020). Loneliness on the other hand is predominantly a subjective assessment in literature (Holt-Lunstad, Smith, Baker, Harris & Stephenson, 2015; Hodgson et al., 2020; Barnes et al., 2022). Subjective indicators of social isolation have seen associations with

mental health outcomes; in contrast objective indicators may not be consistently associated with mental health (Fiordelli et al., 2020). Our study defined both loneliness and social isolation as subjective perceptions, and we found that there may be some degree of distinction between these concepts among older adults in Singapore.

### **POLICY IMPLICATIONS**

Our initial discovery highlighted a link between a sense of helpfulness and reduced social isolation. Also, our simulations show that interventions that target a sense of meaning, or helpfulness would hypothetically reduce feelings of social isolation. This insight holds significance for policymakers, particularly considering that some local initiatives, such as the 2023 Action Plan for Successful Ageing by the Ministry of Health (MOH, 2023), may not explicitly address perceived helpfulness or altruistic sentiments. Hence, our findings provide additional support for policies that aim to promote helpfulness among older adults. A potential concerted strategy could involve promoting helpfulness through diverse programs like encouraging voluntary work, to help older adults embrace practices that hold personal meaning to them, thereby enhancing their perceived helpfulness. Policymakers need to ensure that these volunteer programs are not perceived as exploitative, as this could undermine the core values of volunteering, including empowerment and civic engagement (Hustinx, Grubb, Rameder & Shachar, 2022). Doing so could negatively impact their sense of purpose and meaning, which may diminish their sense of helpfulness.

These initiatives could align with health campaigns like Healthy SG, conveying the message that older adults should prioritize not only their physical well-being but also actively engage in practical helpful behaviours for others. Older adults may also desire to engage in prosocial activities like volunteer work (Lockwood et al., 2021), but our data suggest that poor health may interfere with their ability to do so. Promoting good health should be targeted as an enabler that may allow them to enhance their sense of helpfulness. Policy makers could consider health as a pathway that potentially leads to a greater sense of helpfulness, which may reduce social isolation.

### **LIMITATIONS AND FUTURE DIRECTION**

Our study, however, is not without limitations. While we perform cross sectionally, longitudinal methods may further strengthen the measurable causes of social isolation. This is also a limitation of causal inferences, where causality is merely inferred. Nonetheless, our exploratory study has reinforced the important relationship between perceived helpfulness and perceived social isolation. Future research could examine the implications of this relationship, and

how it could be relevant to the unique cultural context of Singapore. Our study also revealed a directional relationship between perceived loneliness and perceived social isolation among older adults in Singapore. It is necessary to replicate our findings with longitudinal and intervention-based research designs to resolve frameworks that presuppose a bidirectional relationship between social isolation and loneliness (Hodgson et al., 2020; Barnes et al., 2022).

## **CONCLUSION**

In conclusion, our study found two key findings. Firstly, there is an inferred causal relationship between perceived helpfulness and perceived social isolation. This contributes by giving evidence for scholars to expand their conceptualization of social isolation to consider additional psychological factors. Herein, we produced a unique direction, which may either resolve conflicting perspectives or aid the generation of new theories and hypotheses. Secondly, our work illustrates the potential of using computer science methodology to test and advance social science models and theories. Simulated interventions can highlight the promise of intervening at different points along the causal chain to effect change in key outcomes (e.g., reducing social isolation). Our data suggest that initiatives that can spur feelings of helpfulness among older adults are likely to reduce perceived social isolation. Our simulations also support the channelling of resources towards multiple initiatives that examine health, mood, and feelings of helpfulness, that may alleviate perceived levels of social isolation.

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### ***About the Centre for Research on Successful Ageing (ROSA)***

ROSA is a multidisciplinary research centre based in SMU. It was established with an MOE Tier 3 social sciences research grant, as well as the generous support of The Ngee Ann Kongsi. Research at ROSA seeks to define and measure a holistic construct of well-being and to identify the factors that impact Singaporeans' well-being as they progress through the later phases of life. Through close collaboration with government and other partner agencies, ROSA also aims to translate research insights into policy innovations that advance the well-being of older adults holistically and promote successful ageing in Singapore. ROSA brings together a diverse team of leading international and local researchers in ageing and age-related issues from various disciplines. Through empirical evidence derived from a longitudinal methodological approach, the multidisciplinary and multi-institutional research team advances propositions that promote successful ageing in Singapore.

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