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**Impact of integrated mental healthcare on food insecurity of households of people with severe mental illness in a rural African district: a community-based, controlled before-after study**

Short title: Impact of mental health care on food insecurity for people with severe mental illness

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## **Abstract**

### **Objectives**

The objectives of the study were to (1) Evaluate the impact of integrated mental healthcare upon food insecurity (FI) in households of people with SMI in a rural Ethiopian district, and (2) investigate mediation by improved work impairment and discrimination.

### **Methods**

A community-based, controlled before-after study was conducted. People with probable SMI were identified in the community, diagnosed by primary healthcare workers, with diagnostic confirmation from a psychiatric nurse. Households of a person with SMI were matched to control households. District wide integration of mental healthcare was implemented. Change in FI status over 12 months follow-up was measured using the Household Food Insecurity Access Scale. Multivariable models were used to assess improvement in FI. Direct and indirect mediators of change in FI status were modelled using path analysis.

### **Results**

A total of 239 (81.8%) people with SMI and 273 (96.5%) control households were assessed after 12 months. Maintenance of food security or improvement in food insecurity status was observed in 51.5% of households of a person with SMI compared to 39.7% of control households (adjusted risk ratio 1.41: 95%CI 1.11, 1.80). Reduction in symptom severity was indirectly associated with improved FI status via an impact on reducing work impairment and discrimination ( $p < 0.001$ ).

## **Conclusions**

Improving access to mental healthcare may reduce food insecurity in households of people with SMI. Optimising engagement in care and adding interventions to improve work functioning and tackle discrimination may further reduce food insecurity.

## **Key words**

Poverty; mental illness; schizophrenia; bipolar disorder; sub-Saharan Africa; task-sharing;

## **Declaration of interest**

None

## **Funding**

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## Background

Severe mental illnesses (SMI; including psychotic disorders and bipolar disorder) are associated with recurrent or enduring work impairment (1), lower employment levels (2) and increased risk of poverty (3). For people with SMI living in low- and middle-income countries (LMICs), the situation can be particularly stark due to limited access to disability payments or other forms of social welfare (3). Indeed, we found previously that one-third of households of a person with SMI in a rural Ethiopian community were affected by severe food insecurity, an extreme manifestation of poverty (4). This level of food insecurity was significantly higher than that seen in the general population.

Although poverty can predispose to SMI (social causation), it is the consequence of developing SMI that is understood to make the largest contribution to poverty (social drift) (3). Effective treatment for SMI may, therefore, be an important poverty reduction strategy. In our previous study, we found that food insecurity in households of people with SMI was associated with poor social support, experience of negative discrimination, higher disability and lower household annual income, but not with symptom severity (5). Similarly, in a community sample of people with SMI in a neighbouring district, disability was associated with internalized stigma in addition to symptom severity (6). Building on these findings, a participatory planning approach emphasized the need for an holistic and multi-faceted approach to care for people with SMI in order to support recovery (7). A task-sharing model of primary care-based mental healthcare was, therefore, combined with interventions at the community and organizational

levels (8). In this paper we present findings evaluating the household level impact of this fully integrated model of mental healthcare on food insecurity. We hypothesized that:

- (1) district wide mental healthcare would result in reduced household food insecurity over a 12-month period of follow-up, after accounting for secular trends in food security levels in the general population,
- (2) there would be a significantly greater change in food insecurity in people with SMI who attend 50% or more of their follow-up appointments, and that
- (3) any effect of mental healthcare on household food insecurity status would be mediated by reduction in psychotic symptom severity, disability, work impairment and negative discrimination, and improved annual household income.

## **Methods**

The study design was a community-based, before-after study with a general population control group to account for secular trends. Assessments were conducted at the time of initial engagement with the new mental healthcare service (baseline) and after 12 months. Data collection was carried out from December 2014 to September 2016.

## **Setting**

The study was conducted in the predominantly rural district of Sodo, Gurage Zone of the Southern Nations Nationalities and Peoples' Region of Ethiopia, approximately 100 km south of the capital city, Addis Ababa. The district has an estimated population of 165,000 people (9).



Mixed agriculture is the dominant means of livelihood. At the baseline of the study, there were no mental health services in the district.

### **The mental healthcare programme**

The district mental healthcare programme was developed as part of an implementation research project, the Programme for Improving Mental HealthcarE (PRIME) (8). At the health administration level, the focus of interventions was to raise awareness about mental health. All clinicians working in government-owned primary care health centres in the district (n=128), including nurses, midwives and health officers, were trained for 10 days to provide frontline care for people with SMI, depression, epilepsy and alcohol use disorders using a contextualized version of the World Health Organization's mental health Gap Action Programme (mhGAP) intervention guide (8, 10). Face-to-face clinical supervision was provided at least monthly by project psychiatric nurses, with consultations by phone as needed. Community-based health extension workers (n=96) were trained for two days by psychiatrists and psychiatric nurses about symptoms of mental illness, detection of medication side effects, community awareness-raising and outreach to engage people with SMI in ongoing care. The district intervention also included general community mobilization and awareness-raising, but no formal interventions to address food insecurity or livelihood needs.

### **Participant recruitment and follow-up**

Recruitment procedures have been described in detail previously (4). In brief, community key informants detected people with possible SMI and referred them to the nearest health centre

for assessment and initiation of treatment by the trained PHC worker. Any person diagnosed as having a psychotic disorder or bipolar disorder was then invited to participate in the study. Capacity to consent to participate was assessed by research psychiatric nurses who were trained and supervised by senior Ethiopian psychiatrists. For people with SMI who lacked capacity to consent to participate, caregiver permission was obtained. As an additional safeguard, people with SMI who lacked capacity to consent were excluded if they appeared to indicate any unwillingness to participate in the study, for example, by walking away or appearing to be unhappy with the interview procedures. We have used this approach previously to maximise safeguards for vulnerable study participants while seeking to ensure that participants were representative of people with SMI who may be future recipients of the scale-up of integrated mental health care in Ethiopia (11).

The psychiatric nurses then assessed participants using a standardized clinical diagnostic interview, the Operational Criteria for Research (OPCRIT) (12). A series of research measures were then administered. Measures were administered to the person with SMI in the presence of the caregiver in order to triangulate responses.

Within four weeks, a home visit was carried out to obtain economic information from a knowledgeable household informant as part of the Emerging Mental health systems in LMICs project (Emerald) (13).

The household of the person with SMI was matched by age (+/-5 years), sex, household position (household head vs. not head), household size and area of residence (*'gott'*), to a comparison household which did not include a person with SMI. The comparison households

were identified using data from a complete census carried out by PRIME (14). If more than one match was identified, the respondent was selected by lottery. If no respondent was identified after three home visits, or if they declined to participate, the next reserve was selected.

### **Sample size**

The sample size for this follow-up study was based on the primary outcomes of the PRIME (15) and Emerald (13) studies. See supplementary file 1.

### **Eligibility criteria**

Inclusion criteria for people with SMI: aged 18 years or older, planning to stay resident in the district for the next 12 months, provided informed consent or, if lacked capacity to consent, did not refuse and guardian permission was obtained, confirmatory psychiatric nurse diagnosis using OPCRIT, and able to understand Amharic, the official language.

Inclusion criteria for household respondents (in households with and without a person with SMI): aged 18 years or above; provided informed consent; resided in the household for a minimum of four months; household head or the spouse or the most knowledgeable person about the household.

### **Measures**

**Primary outcome:** Food insecurity status. The household food insecurity access scale (HFIAS) was used to assess the access dimension of food insecurity (16). The HFIAS has been translated

into Amharic and validated in a neighbouring district (17). HFIAS allows categorization of households as food secure or having mild, moderate or severe food insecurity.

### **Potential confounding variables (lay interviewer-administered)**

Information about socio-demographic characteristics (age, sex, residence (urban/rural), household position (head vs not head), educational level) were obtained from self-report. Household measures, including annual income, number of household members with long-term illness and number of dependents, were assessed using items from a household economic survey adapted from the WHO study on global ageing and adult health (18).

### **Potential predictors and mediators**

#### Lay interviewer-administered measures:

**Discrimination:** Experience of negative discrimination was measured using the ‘unfair treatment’ sub-scale of the discrimination and stigma scale-12 (DISC-12) (19). Following adaptation (4), 17 items were summed to give a total score indicating extent of experienced discrimination.

**Physical impairment** was measured using the brief physical impairment checklist on items from the Washington Group General Disability Measure and the Family and Wellbeing Index (20, 21).

**Disability** was measured using the World Health Organization Disability Assessment Schedule (WHODAS) 2.0 12-item version (22). This measure was validated for use in people with SMI in the neighboring district (23). The simple WHODAS scoring method was used in this study.

## Psychiatric nurse-administered measures

The following measures were administered by psychiatric nurses:

**Work impairment:** Work-impairment was measured using the Longitudinal Interval Follow-up Evaluation-Range of Impaired Functioning Tool (LIFE-RIFT) (24). The LIFE-RIFT integrates information from the person with a mental health problem, the caregiver and the clinician's judgement following detailed interview. The validity and reliability of LIFE-RIFT has been established in high-income country settings (24). In this study, the work domain of LIFE-RIFT was used.

**Symptom severity** was assessed using the 24-item Brief Psychiatric Rating Scale-Expanded version, BPRS-E (25). The BPRS-E is an observer-rated symptom scale assessed by a clinician, and has been translated into Amharic and used in Ethiopia previously (26).

### **Potential effect modifier**

Data on the PHC attendance for mental healthcare and medication prescribed were extracted from clinical records and cross-checked against facility registers.

### **Training of lay interviewers**

Lay interviewers were recruited from the study locality, with an educational level ranging from tenth grade to Bachelor's degree. The training lasted for twelve days and was carried out by a team of trainers, including research assistants and PhD students.

### **Training of clinician assessors**

The psychiatric nurse assessors were trained for seven days by senior Ethiopian psychiatrists.

### **Data management**

Supervisors monitored data quality. Double data entry was carried out using Epidata (27).

### **Statistical analysis**

Stata software version 14.0(28) and AMOS version 21.0 (30) were used for data analysis.

Descriptive characteristics of people with SMI and comparison households were compared using appropriate statistical tests (Pearson chi-squared test; Kruskal-Wallis and two-sample t-test).

### **Primary analysis**

For the primary analysis examining change in categorical food insecurity status in households of persons with SMI and comparison households, a Poisson working model with sandwich estimators of the standard error was used to estimate the risk ratio (31). HFIAS was categorized as 'improved' if the household remained food secure or moved to a more food secure category between baseline and 12 months (e.g. from severe to moderate food insecurity) and 'non-improved' if the household remained in the same category of food insecurity or moved to a less food secure category. As a secondary analysis, the mean difference in change in HFIAS score between households of people with SMI and comparison households was modelled using multiple linear regression. In view of the higher loss to follow-up from the sample of households of a person with SMI, we carried out multiple imputation to reduce potential bias in the estimates. Data were imputed using chained equations, 30 cycles and assessment of Monte

Carlo error. Analyses using the multiply imputed datasets are presented as the primary analyses, with complete case analyses in the supplementary files.

Multiple linear regression was carried out to examine factors associated with change in mean HFIAS scores in households of people with SMI. An interaction term for clinic attendance (6 or more appointments vs. 5 or fewer) and disability score was included in the final multivariable model and likelihood ratio test used to investigate improvement in model fit. These analyses were conducted using complete case analysis.

A path model was used to investigate the direct and indirect pathways through which reduction in severity of SMI symptoms was associated with changes in food insecurity status. See supplementary file 2 for the hypothesized path model and supplementary file 3 for fit indices and further analysis detail. The statistical significance of the indirect effects of the variables in the model was investigated applying the bootstrapping method, whereby observations with non-missing data were considered for analysis.

### **Ethics statement**

Ethical approval was obtained from the Institutional Review Board of the College of Health Sciences, AAU (Ref. 026/15/Psy) and the Human Research Ethics Committee at the Faculty of Health Sciences, University of Cape Town (HREC Ref: 412/2011). Written informed consent was obtained where possible. For non-refusing people with SMI who lacked capacity to consent, permission was obtained from the caregiver. Non-literate participants gave a finger-print, with

formal recording from a literate witness that the information was explained according to the written materials.

## **Results**

From the 292 households of a person with SMI assessed at baseline, a total of 239 (81.8%) individuals and 239 (81.8%) household respondents were re-assessed at 12 months. A total of 273 (96.1%) comparison households were re-assessed at follow-up. Reasons for loss to follow-up are shown in supplementary file 4. Ten people from the SMI cohort died, compared to no deaths in the control households and one death in the SMI households.

There was no evidence of significant differences in baseline characteristics of age, sex, annual income, household position, severe food insecurity or marital status in those who were lost to follow-up (see supplementary file 5).

### **Sociodemographic and clinical characteristics**

See table 1. Compared to respondents from households without a person with SMI, people with SMI were significantly younger, had fewer children, had lower annual income, were more likely to have attended formal education and be female, unemployed, unmarried and not the household head. In people with SMI at baseline, the median BPRSE score was 47 (IQR = 24) and 69 (29.4%) were taking psychotropic medication.

[Table 1 about here]



## **Change in food insecurity and potential mediator variables**

Overall, 51.5% of households with a person with SMI either maintained food security or experienced an improvement in food insecurity category compared to the comparison households (39.7%). The proportion of households of people with SMI categorized as severely food insecure declined from 30.0% (71/237) at baseline to 15.6% (37/237) at 12 months, compared to a reduction from 13.6% (37/273) at baseline to 9.2% (25/273) at 12 months in comparison households.

Households of people with SMI had a significantly greater reduction in mean food insecurity score from baseline to 12 months compared to households without a person with SMI. The difference in mean HFIAS change between the two groups was -2.2; 95%CI -3.28, -1.05).

The change in potential mediators of food insecurity change between baseline and 12 months was as follows: symptom severity (mean BPRSE change -5.2, 95%CI -7.82, -2.58), disability (mean WHODAS change -7.3, 95%CI -11.7, -2.78), annual income (mean change 6384.6 Birr; 95%CI 4782.53, 7986.63), discrimination (mean DISC change -2.35, 95%CI -3.26, -1.43), work impairment (mean LIFE-RIFT change -0.4, 95%CI -0.62, -0.17).

## **Multivariable analysis**

**Food insecurity:** In the fully adjusted model, the odds of improvement in food insecurity category at 12 months in households of people with SMI were significantly higher than in comparison households: adjusted risk ratio 1.41: 95%CI 1.11, 1.80). (Table 2). [Table 2 about here]

Similarly, change in mean food insecurity score at 12 months was higher in households of people with SMI compared to households without a person with SMI: adjusted beta coefficient ( $\beta$ ) 2.98 (1.45, 4.51). Supplementary file 6c.

In people with SMI, improvement in food insecurity was associated with current household head position (adjusted mean difference (AMD) -2.54; 95%CI -4.92, -0.16), disability score (AMD -0.05; 95%CI -0.09, -0.01) and physical impairment (AMD -0.93; 95%CI -1.68, -0.17). See Supplementary file 7. Only a quarter of participants (n= 60/239; 25.1%) attended for six or more monthly appointments (i.e. 50% of the follow-up period). There was no evidence of effect modification by attendance at follow-up appointments.

### **Path Analysis**

Two of the associations in the hypothesized path diagram (disability to discrimination and symptom severity to income) were removed as they were non-significant and affected the model fit adversely. The standardised path coefficients obtained for the final path model are presented in Fig 1.

[Fig 1 about here]

The model fit was acceptable for all indices: Comparative Fit Index = 0.99, Tucker Lewis Index = 0.99 and Root Mean Square Error of Approximation = 0.01, 90%CI 0.00, 0.09).

Change in psychotic symptom severity was positively associated with change in disability (mean difference = 0.30, 95%CI 0.07, 0.53) and change in work impairment (mean difference = 0.03, 95%CI 0.02, 0.04); but not with change in food insecurity. Similarly, change in discrimination (mean difference = 0.47, 95%CI 0.35, 0.59) and change in work impairment (mean difference = 0.85, 95%CI 0.26, 1.43) were positively associated with change in food insecurity. These associations were positive in both the direct and total effects analysis (see table 3 and supplementary file 8).

[Table 3 about here]

Symptom severity had a statistically significant total effect on discrimination (mean difference = 0.17, 95%CI 0.03, 0.32) but no statistically significant direct effect. However, change in symptom severity was found to have a statistically significant indirect/mediated effect on change in food insecurity status (mean difference = 0.15, 95%CI 0.07, 0.26;  $p < 0.01$ ), through impacting on work impairment and discrimination (supplementary file 9).

## **Discussion**

In this community-based, controlled before-after study conducted in a rural Ethiopian district where an integrated mental healthcare plan was implemented, there was significantly greater improvement in food security in households of people with SMI compared to the secular trend

in the general population. Change in severity of psychotic symptoms was directly associated with change in disability and work impairment, whereas change in food insecurity status was directly associated with work impairment and discrimination. There was an indirect association between reduction in symptom severity and improved food security, operating via a reduction in disability and work impairment. There was no effect modification by number of appointments attended.

The mental healthcare programme was multi-faceted and the impact on food insecurity may have resulted from several aspects of the programme working in concert. In previous studies, antipsychotic medication has been shown to lead to improved occupational, educational and work functioning (32), a beneficial impact on productivity levels (33) and work engagement (34), as well as a reduction in symptom severity (35). In a follow-up study (2.5 years on average) conducted with 271 people with schizophrenia in a neighbouring Ethiopian district who accessed free psychotropic medication through psychiatric nurse-led out-patient care, significant reduction in psychosis symptom scores was associated with improvements in physical and social functioning in people with both recent-onset and long-standing illness (36). In our study, there was a low level of attendance at the PHC facility. As psychotropic medication is usually prescribed monthly in this setting, it means that most people with SMI were not receiving medication for more than 50% of the follow-up period. The lack of effect modification of the change in food insecurity by attendance at appointments is in keeping with what we found for outcomes of clinical symptom severity and disability (37). The pattern of clinic attendance, which showed repeated engagement and disengagement (37), may explain the

following. In our nested qualitative study, people with SMI reported that they tended to attend when they were unwell and not for maintenance care (38).

There was a statistically significant total effect of reduced psychotic symptom severity on level of reported discrimination, with the direct effect close to significance and the indirect effect not statistically significant. In qualitative interviews with community stakeholders during development of the district mental healthcare plan, stigma and discrimination were predicted to reduce when the community witnessed people with SMI show improvement with treatment (38). Social contact interventions, whereby people gain direct exposure to people with SMI and learn about the treatability of their condition are the most effective means of reducing stigma and discrimination (39). Reduction in perceived discrimination and work impairment were also independently and directly associated with improved food security. In a subsistence farming community where there is interdependence between community members, a reduction in social exclusion is expected to result in more livelihood opportunities and access to shared community resources, thereby leading to reduced food insecurity (40). The PRIME integrated mental healthcare plan may also have contributed to greater social inclusion through community mobilisation. As previously reported, a high proportion of people with SMI who reported community support over the follow-up period and the borderline significance of an interaction between receipt of community support with symptom reduction over time ( $p=0.19$ ) and disability ( $p=0.09$ ) (37). In our study, there was no association between change in household income and food insecurity level. This indicates that food insecurity is not just related to the capacity of the household to purchase necessary food. Given that most

participants were subsistence farmers, the capacity of household members to work productively (free from ill-health and the need to care for ill family members) and co-operatively (not socially excluded) with other households may be the over-riding influences on food access.

Our study indicates that scale-up of mental healthcare can support economic inclusion of people with SMI, with impact on a key Sustainable Development Goal to end hunger and achieve food security by 2030. However, although there was significant improvement in food insecurity in people with SMI, the 12-month level of severe food insecurity remained higher than that of the general population (15.6% vs. 9.2%). Concerted effort needs to be made to strengthen engagement of people with SMI in care and ensure the affordability of psychotropic medications. Specific interventions to alleviate food insecurity, reduce discrimination and increase livelihood opportunities may also be required alongside the provision of integrated mental healthcare. Community-based rehabilitation could be one approach to combining these specific interventions and is being trialed in the study district (41).

### **Strengths and Limitations**

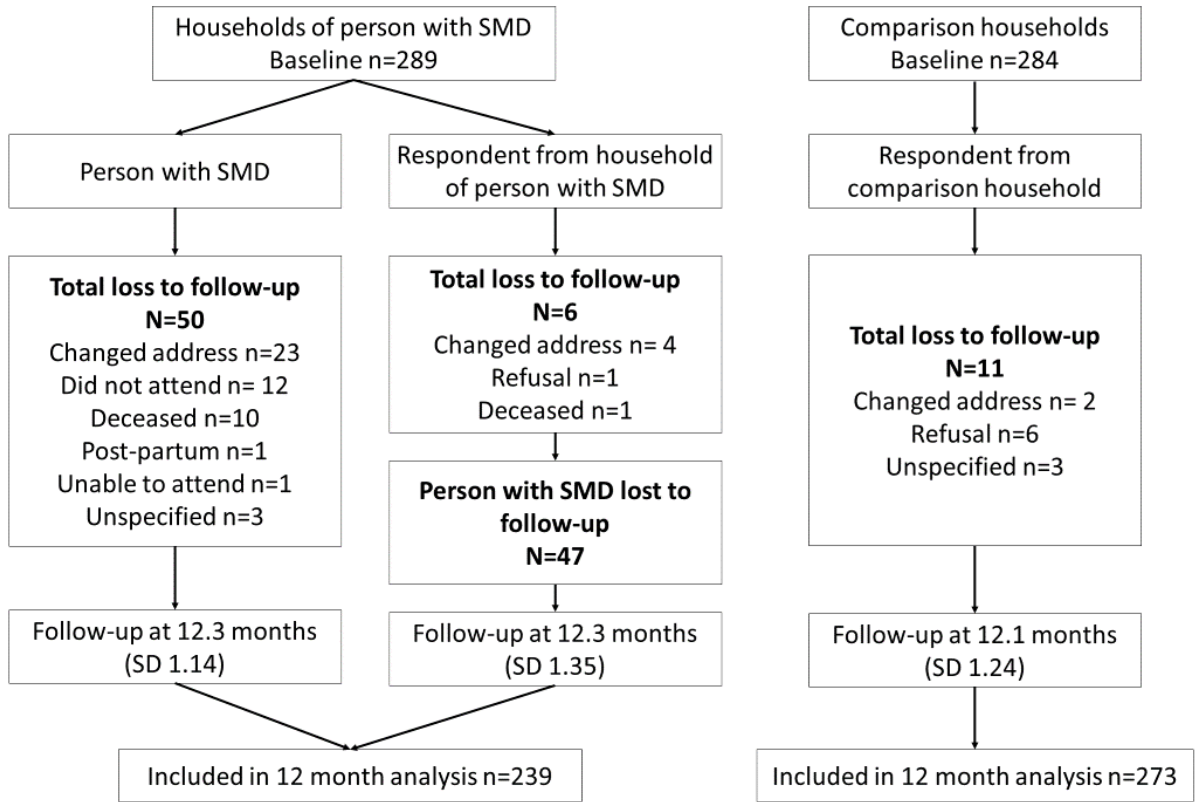
Recruitment of a community-based sample increased the generalizability of the findings. A randomized design would have been preferable, but it was considered unethical to compare the new mental healthcare service to 'treatment as usual' due to the low coverage of effective care at baseline. Although there was no control group of people with SMI who did not receive

the new integrated primary mental healthcare service, in previous longitudinal studies of people with SMI who are not receiving treatment, there was little evidence of spontaneous remission of symptoms (42). We accounted for secular trends which may occur due to variation in the food productivity of a district. We did not record the proportion of participants who lacked capacity to consent, but safeguards were in place to protect vulnerable participants and the sample was as close as possible to people with SMI in the community who may be recipients of integrated primary mental health care. The sample size and prospective design allowed us to model indirect and direct pathways to impact. Other strengths included the use of clinical assessments, validated and standardized measures.

### **Implications**

Findings from this study indicate that provision of fully integrated mental healthcare in this rural Ethiopia district was associated with an improvement in food insecurity status for households with a member living with SMI, beyond that observed due to secular trends. Optimising engagement in care and providing additional interventions to improve work functioning and tackle discrimination may further reduce food insecurity in this vulnerable group.

**Study participants**





**Table 1. Baseline sociodemographic and clinical characteristics of study participants who were re-assessed at 12 months**

Characteristics	Person with severe mental illness (n=239)	Comparison household respondent (n=273)	P-value*
	N (%)	N (%)	
Educational Level			
Formal education	112 (46.9)	92 (33.7)	<0.002
Illiterate/no formal education	127 (53.1)	181 (66.3)	
Sex			
Female	108 (45.2)	73 (26.7)	<0.001
Male	131 (54.8)	200 (73.3)	
Residence			
Urban	44 (18.5)	53 (19.4)	0.790
Rural	194 (81.5)	220 (80.6)	
Household position			
Head	94 (39.3)	267 (98.2)	<0.001
Not head	145 (60.7)	5 (1.8)	
Occupation			
Unemployed	74 (31.1)	1 (0.4)	<0.001
Agriculture	58 (24.4)	174 (63.7)	
Housewife	49 (20.6)	35 (12.8)	
Other <sup>v</sup>	57 (23.9)	63 (23.1)	
Marital status			
Single	110 (46.0)	2 (0.7)	<0.001
Married	84 (35.2)	211 (77.6)	
Divorced	30 (12.6)	10 (3.7)	
Widowed	7 (2.9)	45 (16.5)	
Married but living apart	8 (3.4)	4 (1.5)	
	<b>Mean (SD)</b>	<b>Mean (SD)</b>	
Age (years)	35.4 (13.63)	49.6 (13.76)	<0.001
Month of assessment <sup>‡</sup>	4.3 (3.32)	5.5 (1.84)	<0.001
	<b>Median (25<sup>th</sup>, 75<sup>th</sup> centiles)</b>	<b>Median (25<sup>th</sup>, 75<sup>th</sup> centiles)</b>	
No. of members with long-term illness	0 (0, 0)	0 (0, 0)	0.748
Number of children	1 (0, 3)	4 (2, 6)	<0.001
Annual household income (ETB)	6350 (3000, 11,000)	9000 (5000, 15,000)	<0.001
Number of dependents	2 (1, 3)	2 (1,4)	0.007
Physical impairment total score	1 (0, 3)	-	-
Disability score (WHODAS-12)	23 (14, 32)	2 (0, 7)	<0.001
Work impairment score (LIFE-RIFT)	5 (3, 5)	-	-
Psychosis symptom severity score: BPRS-E	47 (35, 59)	-	-
Discrimination total score (DISC)	6 (1, 15)	-	-

\*P-values of Pearson Chi-squared for categorical variables, Kruskal-Wallis for continuous non-normally distributed descriptive variables and two-sample t-test with equal variances for continuous normally distributed variables. <sup>‡</sup> months numbered starting from January; HFIAS: Household Food Insecurity Access Scale; ETB: Ethiopian Birr; WHODAS: World Health Organization Disability Assessment Schedule; LIFE-RIFT: Longitudinal Interval Follow-up Evaluation-Range of Impaired Functioning Tool; BPRS-E: Brief Psychiatric Rating Scale-Expanded; DISC: Discrimination and Stigma Scale; SD: Standard Deviation; <sup>v</sup> Includes: Daily laborer, government employee, run own business, student, pensioned, private firm employee and others.

**Table 2. Factors associated with maintained or improved food insecurity in people with severe mental illness and comparison households over 12 months follow-up (multiply imputed dataset (n=576))**

Characteristics		Crude risk ratio (95% confidence Interval)	Fully adjusted risk ratio (95% confidence Interval)
Sex	Male	Reference	Reference
	Female	0.99 (0.81, 1.21)	0.96 (0.78, 1.18)
Age	Number of years	1.00 (0.99, 1.00)	1.00 (0.99, 1.01)
Residence	Urban	Reference	Reference
	Rural	1.08 (0.83, 1.39)	1.11 (0.85, 1.44)
Education	Formal	Reference	Reference
	No formal education	0.91 (0.75, 1.09)	0.96 (0.77, 1.19)
Current household position	Not head	Reference	Reference
	Head of household	0.91 (0.74, 1.11)	1.15 (0.88, 1.50)
Season of assessment	Harvest season	Reference	Reference
	Pre-harvest season	0.94 (0.77, 1.15)	0.98 (0.79, 1.21)
Household members with any long-term illness		1.17 (0.97, 1.41)	1.17 (0.97, 1.41)
Annual household income		1.00 (1.00, 1.00)*	1.00 (1.00, 1.00)*
Number of household dependents		1.00 (0.95, 1.06)	1.00 (0.95, 1.06)
Household SMI status	Comparison household	Reference	Reference
	Household of person with severe mental illness	<b>1.30 (1.07, 1.57)</b>	<b>1.41 (1.11, 1.80)</b>

\*p>0.05

**Table 3: Parameters for the hypothesised path model with unstandardized regression weights for direct effects**

Pathway		Unstandardized regression weight		p-value
From	To	Mean difference (Estimate)	95% confidence interval	
Symptom severity	Disability	0.30	<b>0.07, 0.53</b>	<b>0.01</b>
Symptom severity	Work impairment	0.03	<b>0.02, 0.04</b>	<b>&lt;0.01</b>
Symptom severity	Discrimination	0.04	-0.00, 0.08	0.05
Symptom severity	Food insecurity	-0.01	-0.05, 0.04	0.81
Symptom severity	Annual income	-69.45	-162.38, 23.48	0.14
Disability	Work impairment	0.00	-0.00, 0.01	0.41
Disability	Food insecurity	0.01	-0.02, 0.03	0.46
Disability	Discrimination	0.01	-0.01, 0.04	0.39
Discrimination	Annual income	-16.62	-261.86, 228.62	0.89
Discrimination	Work impairment	-0.007	-0.03, 0.02	0.63
Discrimination	Food insecurity	0.47	<b>0.35, 0.59</b>	<b>&lt;0.01</b>
Work impairment	Annual income	-425.48	-1315.56, 1064.59	0.84
Work impairment	Food insecurity	0.85	<b>0.26, 1.43</b>	<b>0.01</b>
Annual income	Food insecurity	0.00	0.00, 0.00	0.95

**Supplementary file 1. Sample size estimations for differing assumptions**

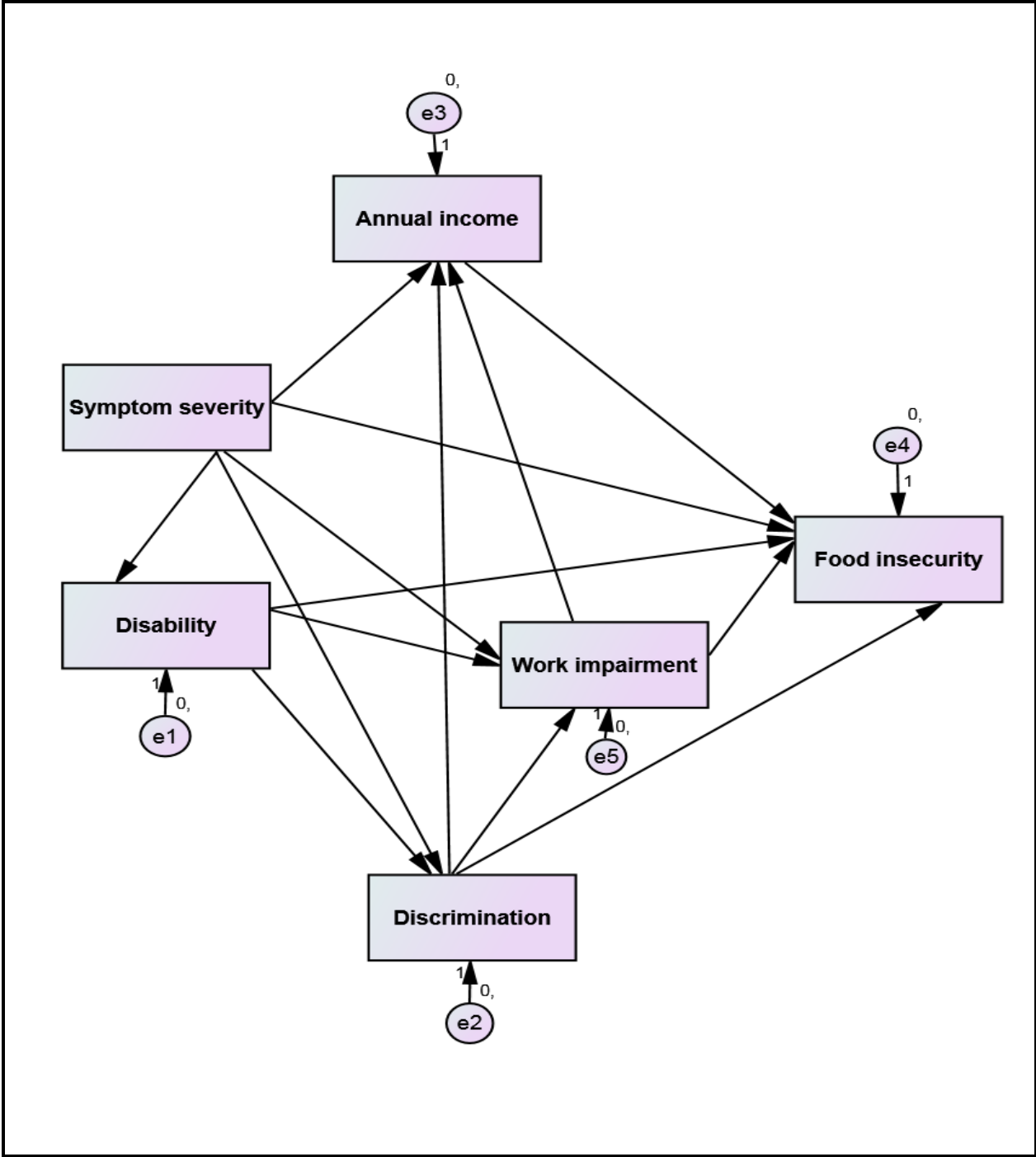
Baseline prevalence of food insecurity in general population	Estimated prevalence of food insecurity in people with SMI	Sample size of people with SMI	Sample size of general population
20%	30%	313	313
	32%	225	225
	34%	171	171
30%	40%	376	376
	42%	267	267
	44%	200	200
40%	50%	408	408
	52%	287	287
	54%	213	213

\* This sample size considers the 10% estimates for the non-response rate.

SMI: severe mental illness

**Note:** Numbers highlighted above indicate possible sample size estimates.

Supplementary file 2. Hypothesized path diagram



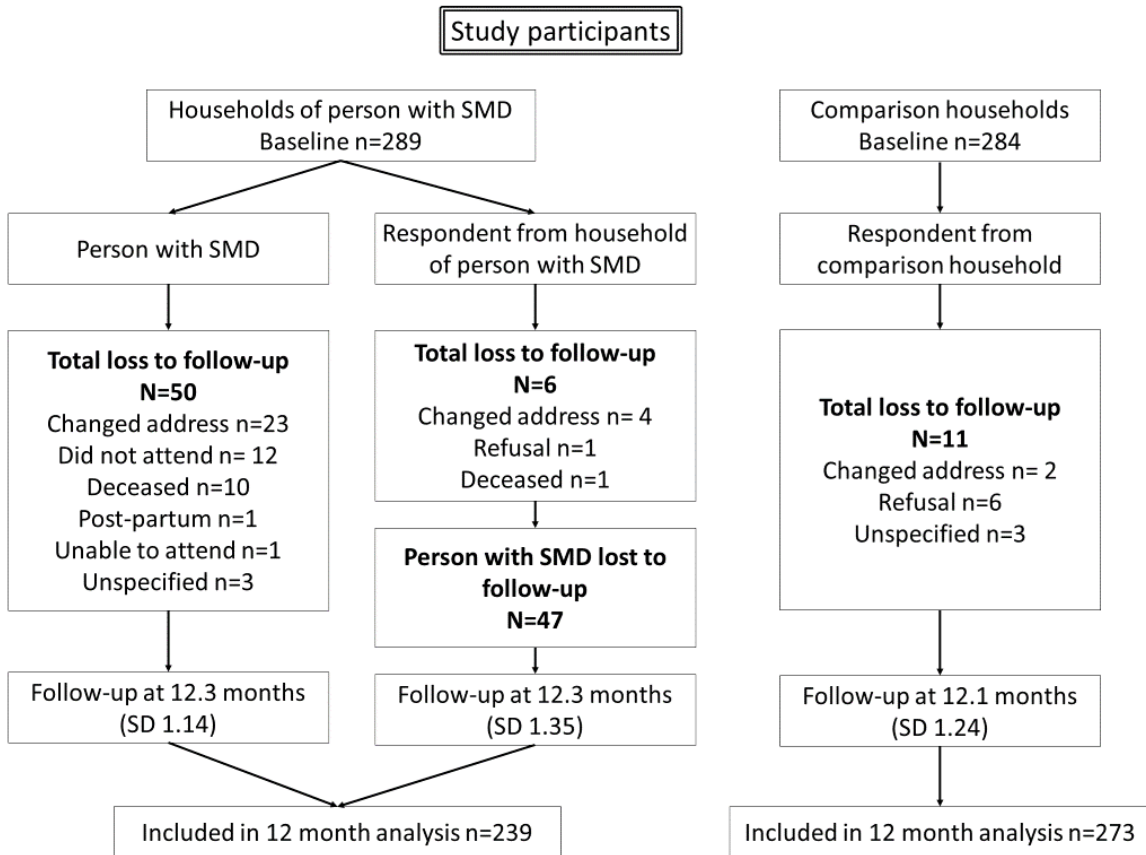
Difference in scores between baseline and 12 months were considered for all modelled variables  
e1, e2, e3, e4 and e5 are error terms for the observed endogenous variables

### **Supplementary file 3: further detail of Path Analyses**

Acceptable fit for path models is assessed in relation to the following indices: (1) a value of 0.08 or less for Root Mean Square Error of Approximation (RMSEA) and not greater than 0.1 (40), (2) Comparative Fit Index (CFI) is truncated to fall in the range from 0 to 1 although CFI values close to 1 indicate a very good fit (41), (3) Tucker Lewis Index (TLI) between 0 and 1 (42).

SMI symptom severity (total score on the BPRSE) was treated as an observed exogenous variable, whereas other variables were treated as observed endogenous variables and error terms as unobserved exogenous variables.

**Supplementary file 4: Flow chart of loss to follow-up**





**Supplementary file 5. Association between baseline characteristics and loss to follow-up**

Baseline characteristics	Category of participants	
	SMD	Comparison
	p-value*	p-value*
Age	0.68	0.32
Sex	0.14	0.48
Food insecurity severity	0.72	0.53
Annual income	0.38	0.68
Household position	0.08	0.10
Employment	0.83	<b>0.00</b>
Marital status	0.15	0.08

\*Chi-square was used for categorical variables and t-test was used for continuous variables

**Table 6a. Factors associated with maintained or improved food insecurity status in people with severe mental illness and comparison households over 12 months follow-up (complete case analysis)**

Characteristics		Crude risk ratio (95% confidence Interval) N=509	Fully adjusted risk ratio (95% confidence Interval) N= 497
Sex	Male	Reference	Reference
	Female	1.00 (0.81, 1.21)	0.92 (0.74, 1.14)
Age	Number of years	1.00 (0.99, 1.00)	1.00 (0.99, 1.01)
Residence (n=508)	Urban	Reference	Reference
	Rural	1.09 (0.84, 1.41)	1.12 (0.86, 1.46)
Education	Formal	Reference	Reference
	No formal education	0.91 (0.75, 1.10)	0.94 (0.76, 1.18)
Current household position (n=508)	Not head	Reference	Reference
	Head of household	0.90 (0.73, 1.10)	1.16 (0.89, 1.51)
Season of assessment	Harvest season	Reference	Reference
	Pre-harvest season	0.96 (0.78, 1.17)	0.98 (0.79, 1.21)
Household members with any long-term illness (n=504)		1.15 (0.93, 1.43)	1.22 (0.99, 1.49)
Annual household income (n=498) (x 1000 Ethiopian Birr)		1.00 (1.00, 1.01)	1.01 (1.00, 1.01)
Number of household dependents (n=504)		1.00 (0.95, 1.06)	1.00 (0.94, 1.06)
Household SMI status	Comparison household	Reference	Reference
	Household of person with severe mental illness	<b>1.30 (1.07, 1.57)</b>	<b>1.45 (1.13, 1.85)</b>

**Supplementary file 6b: Multivariable analysis of factors associated with change in mean Household Food Insecurity Access Scale (complete case analysis)**

Characteristics		Unadjusted Mean difference (95% Confidence interval)	Fully adjusted mean difference (95% Confidence interval) N=489
Sex [n= 502]	Male	Reference	Reference
	Female	-0.54 (-1.72, 0.64)	0.24 (-1.04, 1.52)
Age [n= 502]	Number of years	0.01 (-0.02, 0.05)	-0.01 (-0.05, 0.04)
Residence [n= 501]	Urban	Reference	Reference
	Rural	-0.14 (-1.58, 1.29)	0.10 (-1.37, 1.57)
Education [n= 502]	Formal education	Reference	Reference
	Not formal	-0.52 (-1.66, 0.64)	-0.48 (-1.80, 0.82)
Current household position [n= 501]	Not head	Reference	Reference
	Head of household	0.65 (-0.61, 1.89)	-1.53 (-3.22, 0.15)
Season of assessment [n= 502]	Harvest season	Reference	Reference
	Pre-harvest season	0.06 (-1.11, 1.23)	-0.07 (-1.27, 1.13)
Household members with any long-term illness [total score] [n= 497]	Number	<b>-1.69 (-3.11, -0.28)</b>	<b>-1.71 (-3.15, -0.27)</b>
Annual household income [n= 491]	In Ethiopian Birr	0.00 (-0.00, 0.00)	0.00 (-9.81, 0.00)
Number of household dependents [n= 497]	Number	-0.03 (-0.36, 0.29)	-0.20 (-0.57, 0.16)
Participants or case status [n= 509]	Comparison household	Reference	Reference
	Household of Person with severe mental disorders	<b>1.78 (1.24, 2.56)</b>	<b>-3.36 (-4.90, -1.81)</b>

**Supplementary file 6c: Multivariable analysis of factors associated with change in mean Household Food Insecurity Access Scale (multiply imputed dataset)**

Characteristics		Unadjusted Mean difference (95% Confidence interval) n=576	Fully adjusted mean difference (95% Confidence interval) n=576
Sex	Male	Reference	Reference
	Female	0.41 (-0.74, 1.55)	-0.30 (-1.53, 0.92)
Age (years)	Number of years	-0.01 (-0.05, 0.03)	0.01 (-0.04, 0.05)
Residence	Urban	Reference	Reference
	Rural	-0.04 (-1.49, 1.42)	0.24 (-1.71, 1.23)
Education	Formal education	Reference	Reference
	Not formal	0.33 (-0.81, 1.48)	0.45 (-0.87, 1.76)
Current household position	Not head	Reference	Reference
	Head of household	-0.61 (-1.85, 0.63)	1.32 (-0.39, 3.03)
Season of assessment	Harvest season	Reference	Reference
	Pre-harvest season	-0.13 (-1.28, 1.02)	0.31 (-0.85, 1.48)
Household members with any long-term illness [total score]	Number	<b>1.74 (0.38, 3.11)</b>	<b>1.60 (0.23, 2.98)</b>
Annual household income	Ethiopian Birr x 1000	-0.05 (-0.10, 0.01)	-0.04 (-0.09, 0.01)
Number of household dependents	Number	-0.16 (-0.48, 0.17)	0.02 (-0.33, 0.38)
Participants or case status	Comparison household	Reference	Reference
	Household of Person with severe mental disorders	<b>2.09 (0.96, 3.22)</b>	<b>2.98 (1.45, 4.51)</b>

**Supplementary file 7: Table of factors associated with change in food insecurity score in people with severe mental illness**

Characteristics		Unadjusted mean difference (95% Confidence Interval) N=229	Fully adjusted mean difference (95% Confidence Interval) N=215
Sex	Male	Reference	Reference
	Female	-0.98 (-2.92, 0.96)	-0.06 (-2.11, 1.98)
Age	Years	-0.2 (-0.09, 0.05)	0.02 (-0.06, 0.12)
Residence [n= 228]	Urban	Reference	Reference
	Rural	0.01 (-2.47, 2.49)	0.64 (-1.96, 3.25)
Education	Formal	Reference	Reference
	No formal education	-1.89 (-3.82, 0.03)	-0.73 (-2.93, 1.47)
Current household position	Not head	Reference	Reference
	Head of household	-1.66 (-3.62, 0.30)	<b>-2.54 (-4.92, -0.16)</b>
Season of assessment	Harvest season	Reference	Reference
	Pre-harvest season	-1.24 (-3.44, 0.95)	-1.30 (-3.57, 0.97)
Household members with any long-term illness [n= 224]		<b>-2.23 (-4.41, -0.05)</b>	-1.83 (-4.03, 0.36)
Disability [whodas36 simple]		<b>-0.06 (-0.09, -0.03)</b>	<b>-0.05 (-0.09, -0.01)</b>
Annual household income [n= 221] (Ethiopian Birr)		0.00 (-0.00, 0.00)	-0.00 (-0.00, 0.00)
Number of household dependents [n= 224]		-0.13 (-0.68, 0.43)	-0.22 (-0.82, 0.39)
Physical impairment (total score)		<b>-1.38 (-2.03, -0.73)</b>	<b>-0.93 (-1.68, -0.17)</b>
Work impairment [n= 224] (total score)		-0.56 (-1.29, 0.17)	-0.15 (-1.01, 0.70)

**Supplementary file 8: Path model standardised total (direct and indirect) effects in the bootstrapped model**

Effect in the pathway		Estimate	95% BC confidence interval	p-value
Effect of variable	Effect on variable			
Symptom severity	Disability	0.22	0.11, 0.33	<b>&lt;0.01</b>
Symptom severity	Work impairment	0.38	0.26, 0.49	<b>&lt;0.01</b>
Symptom severity	Discrimination	0.17	0.03, 0.32	<b>0.01</b>
Symptom severity	Food insecurity	0.09	-0.07, 0.24	0.21
Symptom severity	Annual income	-0.02	-0.07, 0.03	0.47
Disability	Work impairment	0.05	-0.09, 0.17	0.51
Disability	Food insecurity	0.07	-0.06, 0.21	0.31
Disability	Annual income	-0.00	-0.02, 0.00	0.36
Discrimination	Annual income	-0.01	-0.15, 0.15	0.92
Discrimination	Work impairment	-0.02	-0.18, 0.12	0.77
Discrimination	Food insecurity	0.46	0.34, 0.58	<b>&lt;0.01</b>
Work impairment	Annual income	-0.04	-0.16, 0.07	0.47
Work impairment	Food insecurity	0.16	0.03, 0.29	<b>0.02</b>
Annual income	Food insecurity	-0.01	-0.16, -0.01	0.84

The standardized total (direct and indirect) effect of other **variables** in the model cannot be tested for significance with p-value; hence their estimates and confidence intervals were not included in the above table

**Supplementary file 9: Path model standardized indirect effects, using a bootstrapped model**

Effect in the Pathway*		Mean difference (estimate)	95% BC** confidence interval (CI)	p-value †
Effect of variable	Effect on variable			
Symptom severity	Work impairment	0.01	-0.03, 0.05	0.79
Symptom severity	Annual income	-0.02	-0.06, 0.05	0.85
Symptom severity	Food insecurity	0.15	0.07, 0.26	<b>&lt;0.01</b>
Symptom severity	Discrimination	0.00	-0.03, 0.04	0.74
Disability	Work impairment	0.00	-0.02, 0.01	0.81
Disability	Food insecurity	0.01	-0.04, 0.09	0.58
Discrimination	Annual income	0.00	-0.01, 0.01	0.81
Discrimination	Food insecurity	-0.00	-0.03, 0.03	0.77
Work impairment	Food insecurity	0.00	-0.01, 0.01	0.83

\*Twelve month baseline scores differences were considered for all modelled variables; \*\*Bias-corrected two-tailed significance; † The standardized indirect (mediated) effect of other **variables** in the model cannot be tested for significance with p-value; hence their estimates, CI and p-values was not included in the above table

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