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Effects of food and water insecurity on depression scores among women living in urban informal settlements in Makassar, Indonesia during the COVID-19 pandemic: a longitudinal cohort study

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Abstract

Effects of food and water insecurity on depression scores among women living in urban informal settlements in Makassar, Indonesia during the COVID-19 pandemic: a longitudinal cohort study

By Isabel Charles

Background: Women living in urban informal settlements may be particularly vulnerable to the detrimental effects of the COVID-19 pandemic due to increased economic and psychosocial stressors in already resource-strapped environments. The objective of this study was to assess the effect of food and water insecurity during the pandemic on depression among women living in urban informal settlements in Makassar, Indonesia.

Methods: We implemented surveys at three time points among women enrolled in the Revitalizing Informal Settlements and their Environments trial. Depression was measured using the Center for Epidemiologic Studies Depression Scale – 10 (CESD-10) in November-December 2019 and again in February-March 2021. Food and water insecurity were measured in August-September 2020. Food insecurity was measured using two questions from Innovation for Poverty Action's Research for Effective COVID-19 Reponses survey. Water insecurity was measured using the short form of the Household Water Insecurity Experiences scale. We ran three multivariate quantile linear regression models to assess the effects of water insecurity, food insecurity, and joint food and water insecurity during the COVID-19 pandemic on subsequent CESD-10 score. Pre-pandemic CESD-10 score, self-reported financial satisfaction, disability, and wealth were included as control variables. There were 323 women with data from the last two time points and 221 women with data from all three time points.

Results: In models with the full sample, food insecurity (β: 1.48, 95% CI: 0.79-2.17), water insecurity (β: 0.13, 95% CI: -0.01-0.26), and joint food/water insecurity (β: 2.40, 95% CI: 1.43-3.38) all had positive relationships with CESD-10 score. In sub-group analyses of respondents for whom we had pre-pandemic CESD-10 scores, results were similar but attenuated. Joint food/water insecurity (β: 1.96, 95% CI: 0.78-3.15) maintained the strongest relationship with CESD-10 score.

Conclusions: In our study, joint food and water insecurity predicted higher (worse) scores on a depression scale among women living in urban informal settlements in Makassar, Indonesia. Our results highlight the importance of addressing food and water insecurity together, rather than in silos as is standard practice. Cross-sectoral coordination may be vital for delivering effective interventions that reflect the complexity of their beneficiaries' lived experiences.

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Introduction

The COVID-19 pandemic had detrimental effects on the wellbeing of individuals globally, as the world faced economic, political, and social shocks that disrupted daily life (Egger et al., 2021; Santana et al., 2021; Santomauro et al., 2021). Urban health practitioners raised concerns over how the COVID-19 pandemic may impact the health and wellbeing of communities living in urban informal settlements, where crowded living spaces, inadequate housing, informal income earning, and poor access to water and sanitation services may lead to increased risk for the social, health, and economic impacts of COVID-19 (Corburn et al., 2020). Women living in urban informal settlements may be at an even higher risk for the poor wellbeing outcomes related to COVID-19, as they are often the primary caregivers at the household and therefore may bear a larger psychosocial burden when facing resource insecurity and economic stressors (Bau et al., 2021; Hamadani et al., 2020).

However, research on psychological wellbeing in urban informal settlements is scant (Sverdlik, 2011), and there are few ongoing studies in these settings, so measuring changes in wellbeing during shocks and stressors is a challenge. Revitalizing Informal Settlements and their Environments (RISE) is a cluster-randomized controlled trial being conducted in 12 urban informal settlements in Makassar, Indonesia. Data collection in RISE includes longitudinal assessments of health and wellbeing of individuals living in study settlements (Leder et al., 2021). Using data collected from three discrete time points (November-December 2019, August-September 2020, and February-March 2021), this longitudinal sub-study seeks to understand the effect of household food and water insecurity on women's self-reported psychological wellbeing during the COVID-19 pandemic.

This study increases the currently limited scope of research on food and water insecurity and mental health, as well as research on women's mental health in urban informal settlements. From a global health practice perspective, understanding how women living in urban informal settlements respond to shocks such as the COVID-19 pandemic may help inform urban health and global health practitioners on how to best design public health interventions that consider the unique experiences of their beneficiaries. This is particularly important as increased urbanization continues to lead to a growth in urban informal settlements globally (World Health Organization, UN-Habitat, 2016).

Literature Review

The Global State of Urban Informal Settlements

Rapid population growth in low- and middle-income countries (LMICs) and migration from rural to urban areas has created a challenge for resource-strapped cities and states to provide residents with adequate permanent housing and infrastructure (Black et al., 2011; Knowledge Network on Urban Settings, 2008). A byproduct of this urban in-migration and population growth is the global sprawl of urban informal settlements: densely populated urban areas characterized by insecurity of tenure, overcrowding, substandard housing, and no or limited access to basic services such as electricity, water, and sanitation infrastructure (UN-Habitat, 2015; UN Habitat, 2003). These conditions make the populations within settlements particularly vulnerable to the economic, social, and health impacts of shocks and stressors. The term "slum" is often used interchangeably with urban informal settlements, although slums are an extreme form of urban informal settlements, characterized by squalor and hazardous infrastructure (UN-Habitat, 2015).

Over 880 million people are living in urban informal settlements worldwide, with over half of that population living in Asia and Sub-Saharan Africa (World Health Organization, UN-Habitat, 2016). This population is estimated to double by 2050. However, some experts suggest that the extent of this issue may be underestimated, as the poorest urban households often go uncaptured by population surveys or government reporting (UN-Habitat, 2015). Individuals living in urban informal settlements face particular social, economic, and health challenges in comparison to other urban populations due to the unique environments they inhabit. For example, residents of urban informal settlements are often spatially excluded from the

opportunities of the urban environment, such as public transportation and public utilities (i.e. electricity and waste management), which in turn leads to economic and social exclusion (UN-Habitat, 2015).

A systematic review of health in slums conducted in 2017 found that only 7% of studies registered on the WHO Clinical Trials Registry platform and less than 3% of studies published on MEDLINE and Embase were conducted in urban informal settlements (Ezeh et al., 2017), indicating a lack of research in these areas. However, the research that has been published shows that populations in urban informal settlements are at increased risk of poor health throughout their lifetime, including higher rates of malnutrition (Kimani-Murage et al., 2015; Sarkar et al., 2013), increased injury and exposure to violence (Daruwalla et al., 2020; Gibbs et al., 2018; Sverdlik, 2011), and increased burden of disease (Fahim et al., 2021; Palit et al., 2012; Sarkar et al., 2013). Poor mental health outcomes and increased risk of mental illness have also been documented as health risks in urban informal settlements (Gibbs et al., 2018; Greif & Nii-Amoo Dodoo, 2015a; Gruebner et al., 2011, 2012).

The 2030 Agenda for Sustainable Development outlines seventeen global goals, known as the sustainable development goals (SDGs), that the United Nations seeks to meet by 2030 in order to achieve economic, social, and environmental development worldwide (UN (United Nations) General Assembly, 2015). Goal 11 calls for global action to "make cities and human settlements inclusive, safe, resilient, and sustainable". In order to achieve this, policymakers, urban planners, and health and development practitioners need to better understand these complex landscapes and the unique social and health risks that exist within urban informal

settlements, particularly as they continue to be a pivotal component of a rapidly urbanizing world (*The Sustainable Development Goals Report 2021*, 2021).

Urban Informal Settlements in Indonesia

Informal settlements account for approximately one-third of Indonesia's urban population (United Nations, 2021). These settlements are often referred to as "kampungs", which translates literally to "village" in Bahasa Indonesian (Rahmi et al., 2001). However, the exact number of urban kampungs in Indonesia is still unclear, and limited research exists on life in kampungs (Simarmata, 2017). There is very little research on health Indonesian informal settlements, and to the author's knowledge there is only one published study to date that explores mental health outcomes in these settings (Carias et al., 2021).

One study by Akbar & Edelenbos (2020) sought to quantify the social outcomes of *place-making*, the process where "places are claimed and shaped through everyday social practices", in kampungs in Indonesia through a set of household questionnaires. Multiple linear regression found that overall social outcomes were positively and significantly associated with place-making activities, with the exception of temporal placemaking and respondent's self-reported quality of life, which were not statistically significant (Akbar & Edelenbos, 2020). This study demonstrates how the collective culture of Indonesian kampungs can in turn lead to positive social outcomes, including social connection, self-reported quality of life, and local capacity for collective action (Akbar & Edelenbos, 2020). The results have implications for how social culture can influence subjective wellbeing as well as environmental outcomes in urban informal settlements – collective "place-making" activities, both informal and formal, encouraged participants to take

care of one another and their neighborhoods, which led to a return on investment in terms of their livelihoods (Akbar & Edelenbos, 2020).

Psychological wellbeing in urban informal settlements

There is growing awareness of the burden of poor mental health and psychological wellbeing globally, particularly in LMICs (Bird et al., 2011; Lund et al., 2010). A systematic review conducted by Lund, et al. (2010) of common mental disorders in LMICs found that nearly 80% of studies showed positive, but nuanced, associations between poverty measures and poor mental health. While certain indicators, particularly income and employment, had more ambiguous associations with mental health status, other indicators of poverty, such as food insecurity and housing, were often strongly associated with poor mental health (Lund et al., 2010). However, research on psychological wellbeing specifically in urban informal settlements is scant.

A study on mental health in slums in Dhaka, Bangladesh, paints a dim picture of mental health in these settings (Gruebner et al., 2011). The researchers conducted a cohort study in nine settlements, using the WHO-5 Well-being Index to measure self-rated mental health status. They found that poor mental health was prevalent in all settlements that were surveyed. Researchers also found using spatial analysis that certain variables, such as gender, housing quality, environmental health knowledge, and sanitation, were associated with a higher risk of poor mental health (Gruebner et al., 2011). These findings imply that mental health disparities exist even within the already vulnerable environments of slums, depending on a range of environmental and demographic factors (Gruebner et al., 2011).

At the same time, at least one study has found better mental health outcomes in urban informal settlements compared to formal housing. Marais et al. (2013) conducted a study of the relationship between mental health and housing conditions among orphans and vulnerable children in the urban area of Manguang Metropolitan Municipality in South Africa. Several housing-related variables were studied in relationship to mental health, including: housing type, housing quality, and urbanization/movement (Marais et al., 2013). Mental health was measured through the strengths and difficulties questionnaire (SDQ), which was taken by the child, caregiver, and teacher to assess child's mental health (Marais et al., 2013). The SDQ test provided a "TD" (total difficulties) score, which sums the results of four behavioral problem scales. Surprisingly, children living in informal urban settlements were less likely to have "clinically diagnosable" TD scores than children living in formal housing (Marais et al., 2013). The authors posit that the historical context of informal settlements in South Africa may explain these results. The formation of urban informal settlements during apartheid was seen as a way for Black South Africans to take back control of their lives (Marais et al., 2013). Some past literature has also pointed to strong notions of collectivism in urban informal settlements as a means of survival (Carpenter et al., 2004; Gumelar et al., 2018; Morgner et al., 2020). While the political and structural environment of urban informal settlements may give way to increased mental health risks, the findings by Marais et al. (2013) imply that perhaps certain aspects of the social environment may play a protective role.

Several other studies have reported similar findings of poor mental health in urban informal settlements influenced by a swath of explanatory factors, from crime rates, to informal employment, to insecurity of tenure (Greif & Nii-Amoo Dodoo, 2015; Zakerhaghighi et al., 2015).

Informal settlements are different all over the world and their inner workings are greatly influenced by history, culture, and varying elements of their environments, so it is impossible to make generalizations about what might be important for mental health in informal settlements globally. Overall, the literature suggests that certain aspects of these unique environments give way to an increased risk of poor mental health. However, there are a number of cultural and social factors, depending on the setting, that may be protective against negative impacts on poor mental health.

COVID-19 and Psychological Wellbeing

The mental health burden of COVID-19 has been profound – one systematic review estimates a nearly 30% increase in prevalence of major depressive disorder and 25% increase in prevalence of anxiety disorder globally due to the COVID-19 pandemic and the subsequent social and economic effects (Santomauro et al., 2021). The pandemic posed specific challenges for psychological wellbeing in LMICs, which may not have the same health system capacity to manage mental health crises as high income countries (De Sousa et al., 2020). Research has found associations between past quarantines, such as during the 2003 severe acute respiratory syndrome or 2004 Ebola virus outbreaks, and poor mental health, such as increased rates of depression, post-traumatic stress disorder (PTSD), and anxiety (Serafini et al., 2020)

A review of the mental health implications of COVID-19 in LMICs found increased reports of psychological distress, particularly among healthcare workers (Kola et al., 2021). This is likely a reflection of the many uncertainties associated with life during COVID-19, particularly under restrictive lockdowns, as well as the health concerns associated with getting the disease in

countries with low health systems capacity (Kola et al., 2021). However, the review found that overall there has been little substantive research on the mental health impacts of the pandemic in LMICs, especially compared to research done in high-income countries. This is concerning considering that the majority of suicides globally occur in LMICs (Naghavi, 2019).

The review also found disruptions in mental health services in LMICs, particularly in areas that were not able to create hybrid models for health services due to unreliable internet connectivity or low technology capacity (Kola et al., 2021). This may deepen the mental health divide that is faced by people of low income status, people with disabilities, and other disadvantaged groups, such as those living in urban informal settlements. The review concludes that the mental health inequities highlighted by the COVID-19 pandemic necessitate a restructuring of how we manage and think about mental health as a global health issue (Kola et al., 2021). There is a need for tackling the stigma of poor mental health in these contexts and developing context-informed interventions.

A study by Porter et al. (2021) examined the effects of COVID-19 on young adults' mental health in Ethiopia, India, Peru, and Vietnam. Study participants were drawn from the Young Lives Study, a longitudinal cohort study that began in 2002 (Barnett et al., 2013). The researchers collected information on symptoms of anxiety and depression using the Generalized Anxiety Disorder-7 (GAD-7) scale and the Patient Health Questionnaire depression scale (PHQ-8). Prior to the pandemic, data on emotional problems and subjective wellbeing had been collected; these data were used as proxies for baseline mental health during analysis (Porter et al., 2021). The researchers found that economic adversity and living in an urban area were correlated with experiencing symptoms of anxiety. Respondents experiencing economic adversity often also

reported reducing food consumption as a coping strategy for the economic stressors (Porter et al., 2021). Furthermore, rates of anxiety and depression were generally much higher in countries that were harder-hit by the pandemic (Porter et al., 2021). This study is one of the most robust in terms of measuring psychological wellbeing outcomes in LMICs because of its' use of proxy indicators for baseline mental health, large sample size, and diversity of participants. Unfortunately, because anxiety and depression were not measured directly in prior surveys, the observed impact of COVID-19 on wellbeing is incomplete.

A study exploring the impact of the COVID-19 lockdown on women and their families in rural Bangladesh found devastating impacts on women's mental, financial, and physical wellbeing (Hamadani et al., 2020). Using an interrupted time series approach, the researchers compared data on food security, income, and mental health collected during the COVID-19 lockdown (May-June 2020) to baseline (July 2017-February 2019) and end line (February 2020) (Hamadani et al., 2020). Food security was measured using the Household Food Insecurity Access Scale (HFIAS) and a shortened version of the Center for Epidemiologic Studies Depression Scale (CESD). The researchers also collected data on anxiety during COVID-19 using the Generalized Anxiety Disorder (GAD-7) tool, although anxiety measures were not taken at baseline or end line (Hamadani et al., 2020). They found that household food security decreased, and moderate and severe food insecurity significantly increased (Hamadani et al., 2020). Furthermore, data showed that the lockdown seemed to have severe impacts on women's mental health – symptoms of depression increased by an average of six points, and nearly 99% of women reported that their anxiety had increased since the lockdowns (Hamadani et al., 2020).

Literature shows that COVID-19 impacted psychological wellbeing globally, in high-, middle-, and low-income countries, through increased rates of anxiety, depression, PTSD, and other forms of psychological distress (Porter et al., 2021; Kola et al., 2021; Santomauro et al., 2021; Hamadani et al., 2020). However, this impact has been challenging to quantify in LMICs. While the paper described above covers both urban and rural environments, there are still large geographic gaps in the literature. Furthermore, to the author's knowledge, there are very few studies that have robust longitudinal data on psychological wellbeing that can be used as a baseline for comparison of wellbeing during COVID-19 in LMICs (Hamadani et al., 2020; Logie et al., 2022). While some studies attempt to use a proxy for baseline data, these measurements may be capturing a different phenomenon and therefore may be providing an incomplete picture of the mental health burden.

Food Insecurity and Psychological Wellbeing in Urban Informal Settlements

Research has linked food insecurity to poor psychological wellbeing globally, causing anxiety, depression, and distress in food insecure households (Elgar et al., 2021). This issue is more pronounced in urban informal settlements, where households are forced to make difficult decisions over how to prioritize their resources in situations of poverty and lack of formal employment opportunities (Abdulla, 2011; Nickanor, 2014).

Rani et al. (2018) describe the results of a cross-sectional study looking at household food insecurity and psychological wellbeing among teenage girls living in urban slums. This study was conducted across five slums in Varanasi, India, using the HFIAS to assess household food insecurity and four components (anxiety, depression, loss of behavioral control, and

psychological distress) from the Mental Health Inventory to assess mental health. The study found that nearly half of the girls interviewed lived in food insecure households. Nearly 87% of study respondents living in food insecure households reported high levels of depression, compared to 31% of those living in food secure households (Rani et al., 2018). Food insecure respondents also reported significantly higher levels of psychological distress and loss of behavioral control in comparison to their food secure counterparts (Rani et al., 2018). After controlling for confounders, multivariate analysis showed that household food insecurity was significantly associated with high anxiety, high depression, high loss of behavioral control, and high psychological distress (Rani et al., 2018).

A cross-sectional study in urban slums in Dhaka, Bangladesh found similar associations between household food insecurity and common mental disorders (Khan & Flora, 2017). The overall objective of the study was to identify factors associated with common mental disorders in mothers in urban slums in Dhaka. The researchers interviewed 264 mothers of children under the age of 5, using a questionnaire composed of questions from the WHO's Self-Reporting Questionnaire-20, the HFIAS, and a socioeconomic status scale, as well as several questions on sociodemographic variables. Of all household characteristics analyzed in bivariate analysis, women experiencing moderate or severe household food insecurity had the highest odds of having a common mental health disorder in comparison to women from food secure households; 4.79 and 11.57 times the odds, respectively (Khan & Flora, 2017). In multivariate analysis, household food security was identified as the best predictor of maternal mental health (Khan & Flora, 2017). This study demonstrates the importance and strength of the link between food insecurity and mental health among women, even when considering other related variables.

A cross-sectional study published by Logie et al. (2020) conducted in Kampala, Uganda focused on understanding the drivers and mediators of depression among refugee and displaced adolescents and youth in urban informal settlements. Depression was measured using the Patient Health Questionnaire-9 (PHQ-9) (Logie et al., 2020). Two-thirds of all survey respondents reported depression symptoms. Girls were much more likely to report depressive symptoms than their male counterparts (Logie et al., 2020). In both bivariate and multivariate analysis, food insecurity was not associated with depression among girls, which deviates from much of the prior literature which has found strong associations between female mental health and food insecurity (Gibbs et al., 2018; Ivers & Cullen, 2011; Maynard et al., 2018). Among boys, food insecurity was associated with a 0.24 increase in depression score when exploring material and symbolic contexts but became insignificant when social support measurements were added. A structural equation model found that food insecurity was not directly associated with depression among boys, but rather with lower social support (Logie et al., 2020). The authors posited that food insecurity, then, is associated with depression in boys through the pathway of a lack of social support.

However, a cross-sectional analysis of data collected among young adults living in urban informal settlements in Durban, South Africa found stronger associations between food insecurity and poor mental health in females (Gibbs et al., 2018). The researchers used the CESD scale to measure depression and a single binary item to measure food insecurity, "How often would you say you go without food because of lack of money?" (Gibbs et al., 2018). They also asked questions on experiencing hunger daily or weekly, stealing because of hunger, and borrowing money or food because of hunger. In bivariate analysis, the direct measure of food

insecurity was associated with higher levels of depression among women, but not among men (Gibbs et al., 2018). Stealing or borrowing food or money because of hunger was highly associated with depression in both men and women (Gibbs et al., 2018). In adjusted multivariate analysis, experiencing hunger daily or weekly was associated with depression in women, while stealing because of hunger was associated with depression in men (Gibbs et al., 2018). While the authors do not attempt to explain these differences between men and women, they do note that past research has also found that direct measures of household food insecurity has associations with poor female mental health in LMICs (Gibbs et al., 2018; Lund et al., 2010). The authors also note that food security-related measurements are more predictive of poor mental health than income-related measurements, which corroborates with prior research (Gibbs et al., 2018; Lund et al., 2010).

While research shows a link between mental health and food insecurity in urban informal settlements, some findings are mixed, particularly in terms of how this relationship differs by gender. Research suggests that women and girls may be especially vulnerable to the impacts of food insecurity on mental health, possibly due to their roles as caregivers (Gibbs et al., 2018; Khan & Flora, 2017). However, boys and young men may be differentially affected by food insecurity when experiencing low levels of social support, as demonstrated by Logie et al (2020).

Water Insecurity and Psychological Wellbeing in Urban Informal Settlements

Like food insecurity, research has linked water insecurity to poor mental health and psychological distress in LMICs (Brewis et al., 2019; Wutich et al., 2020). Research has found that there are physical, social, financial, and perceived inequality related stressors related to lack of

access to safe water (Bisung & Elliott, 2016a). Because women tend to bear the burden of household water collection and serve as caregivers, they may also bear a higher burden of poor mental health as is related to water security (Bisung & Elliott, 2016a; Ennis-McMillan, 2001; Wutich & Ragsdale, 2008). However, this concept is relatively new as compared to food insecurity, so there has been less published research in LMICs (Bisung & Elliott, 2016b) and very little in urban informal settlements.

Wutich & Ragsdale (2008) were one of the first groups of researchers to explore the associations between water insecurity and mental distress in an urban settlement setting. The research team collected data in a Bolivian squatter settlement using a household survey that measured water-related experiences and emotions, including "fear, worry, anger, and bother" as indicators of emotional distress (Wutich & Ragsdale, 2008). The researchers used a multiple linear regression model to test a range of variables with water-related emotional distress. Counter to their hypothesis, they found no associations between actual water supply and emotional distress. They did, however, find that reliance on small-scale markets or a "reciprocal exchange" system for water was associated with emotional distress (Wutich & Ragsdale, 2008). The authors posit that this may be because these systems rely on market negotiation and are less predictable than communal water sources (Wutich & Ragsdale, 2008). The researchers also found that women were significantly more likely than men to report water-related emotional distress (Wutich & Ragsdale, 2008), which aligns with literature on the unique relationship between women and water (Pouramin et al., 2020; Sultana, 2009; Sweetman & Medland, 2017).

A more recent study by Kangmennaang et al. (2020) sought to understand the links between water insecurity and mental distress in urban slums in Accra, Ghana through a mixed-

methods approach. The researchers measured water-related emotional distress, household food and water insecurity, and several other household and sociodemographic variables. Water-related emotional distress was measured through six questions regarding the frequency of water-related psychosocial experiences such as arguments over water (Kangmennaang et al., 2020). Food insecurity was measured through the HFIAS, and water insecurity was measured through the Household Water Insecurity Access Scale. In multivariate analyses, water insecure households were more likely to have reported experiences of emotional distress than water secure households (Kangmennaang et al., 2020). Food insecurity was not a significant predictor of emotional distress (Kangmennaang et al., 2020). While this might be surprising due to the plethora of literature indicating that food insecurity is predictive of psychological wellbeing (Elgar et al., 2021), the measurement for psychological wellbeing in this study focused specifically on water-related emotional distress. Qualitative findings from the study, collected through photovoice and in-depth-interviews, reinforced these findings, with participants expressing stress and concern over how their health may be impacted by their water and over the cost associated with clean water (Kangmennaang et al., 2020)

Based on the studies described above, research on water and psychological wellbeing in urban informal settlements has focused more on water-related emotional experiences, rather than psychological wellbeing as a whole (Kangmennaang et al., 2020; Wutich & Ragsdale, 2008). However, research in this area is slim (Bisung & Elliott, 2016). There is an opportunity for researchers to explore the relationship between overall psychological wellbeing and water insecurity in urban informal settlements.

Food and Water Insecurity, Psychological Wellbeing, and COVID-19 in Urban Informal

Settlements

Studies have found associations between food and water insecurity and poor psychological wellbeing outcomes in resource-scarce environments (Miller, Frongillo, et al., 2021; Young, Miller, et al., 2021), though, as described above, this relationship is less clear and less well-studied in urban informal settlements. A few studies have attempted to explore this relationship in urban informal settlements during the COVID-19 pandemic.

A cross-sectional study conducted in Dhaka, Bangladesh attempts to describe the status of mental health during COVID-19 among residents of urban informal settlements (M. S. Islam et al., 2020). The researchers collected data on the financial impact of COVID-19, depression, and PTSD, as well as several sociodemographic and behavioral measurements. The financial impact of COVID-19 was measured through questions on job loss, food insecurity, and income changes since COVID-19. Depression was measured using the Patient Health Questionnaire-9, and PTSD was measured using the National Stressful Events Survey for PTSD-Short Scale (Islam et al., 2020). A majority of households (96.3%) reported a decrease in household income due to COVID-19 (Islam et al., 2020). In multivariate analysis, higher depression scores were significantly associated with being female, joblessness due to COVID-19, being divorced, living in a joint family household, excessive sleep, and smoking. Higher PTSD scores were significantly associated with income, excessive sleep, joblessness due to COVID-19, and experiencing food scarcity (Islam et al., 2020). In the same vein as the study described prior, there is no "baseline" to describe pre-pandemic mental health, so the causal link between COVID-19 and poor psychological wellbeing is lacking.

Nyashanu et al. (2020) describe findings from in-depth interviews conducted with 30 participants living in urban informal settlements in Tshwane Gauteng province, South Africa. The researchers aimed to explore the impact of the COVID-19 lockdown on individuals living in urban informal settlements. Participants were recruited using convenience sampling, via community contacts provided from community and faith organizations operating in informal settlements in Pretoria, South Africa. They categorized their findings into the following themes: difficulties in practicing social distancing, over-burdened infrastructure in informal settlements, lack of savings, loss of income and shortage of food, hunger and other diseases, anxiety and depression, and poor access to education. In terms of anxiety and depression, interviewees discussed how the lack of ability to social distance, fear of getting COVID-19, and social restrictions impacted their mental health (Nyashanu et al., 2020). Participants also spoke about the food insecurity impacts of COVID-19. Restrictions on movement and quarantine requirements impacted the informal economy, subsequently impacting people's income and forcing households to cut back on food (Nyashanu et al., 2020). This study provides insight into the lived experiences of residents of urban informal settlements during the COVID-19 pandemic and lockdowns; however, due to the qualitative nature of the study, we cannot make draw any inferences about the associations of mental health with other factors, such as food insecurity.

A cross-sectional study conducted in two urban shantytowns in São Paolo, Brazil via an online questionnaire found significant associations between psychosocial distress and experiencing food insecurity during the COVID-19 pandemic (Santana et al., 2021). The researchers used the General Health Questionnaire-12 (GHQ-12) to screen for psychological distress and a shortened version of the Brazilian food insecurity scale to measure food insecurity

(Santana et al., 2021). Multivariate logistic regression found that individuals experiencing moderate to severe food insecurity had 2.7 the odds of reporting psychosocial distress on the GHQ-12. However, due to the cross-sectional nature of this study, we cannot make conclusions on whether food insecurity was a causal factor for depression specifically during COVID-19, as we do not have baseline data for comparison. Furthermore, online questionnaires have several issues related to self-selection bias and ability to accurately describe the population taking the survey, so the representativeness and reliability of the findings in this study are questionable (Andrade, 2020).

In a follow-up to the 2020 study described earlier, Logie et al. (2022) explored the associations and correlations of depression in refugee youth living in informal settlements in Kampala, Uganda prior to (February 2020) and during (December 2020) the COVID-19 pandemic. Depression was measured using the PHQ-9, and food insecurity was measured using a single item on how often the interviewee went to sleep hungry because they did not have enough food to eat (Logie et al., 2022). The researchers also measured the associations between depression, intimate partner violence, and social support (Logie et al., 2022). The odds of depression among those who reported "always" experiencing food insecurity was 2.54 times higher than those who reported "never" experiencing food insecurity (Logie et al., 2022). The researchers also found that in the time period during the pandemic, there was a stronger association with food insecurity and heightened depression, but when adjusting for time as an effect modifier, this relationship was not statistically significant (Logie et al., 2022). There were also no significant changes in rates of depression prior to and during the pandemic. The researchers posit that these findings suggest that depression and its' associated factors are a chronic experience for urban refugee youth, so

a stressor such as the COVID-19 pandemic may not have a particularly large impact when this population is already experiencing the "psychological toll of slum living" (Logie et al., 2022; Subbaraman et al., 2014). To the author's knowledge, this is the only study on depression during COVID-19 in urban informal settlements that uses pre-pandemic baseline data.

There are no studies published to the author's knowledge that look at water insecurity and psychological wellbeing in urban informal settlements during the COVID-19 pandemic. While some studies have attempted to explore food insecurity as they relate to mental health during the COVID-19 pandemic, there are several remaining research gaps. Overall, there is a lack of robust study designs that explore these associations – this may be partially due to the fact that there is little ongoing research in urban informal settlements (Sverdlik, 2011), so many studies do not have baseline data (i.e., psychological wellbeing prior to COVID-19) to which they can compare psychological wellbeing during COVID-19, with the exception of Logie et al.'s research on refugee youth in Kampala (2022). This creates a gap in knowledge in terms of how much we can attribute the mental health status specifically to COVID-19 versus other stressors. As noted by Logie et al. (2022) in their findings, living in urban informal settlements comes with everyday stressors that make way for poor mental and physical health (Subbaraman et al., 2014; Sverdlik, 2011). Depression, water insecurity, and food insecurity in urban informal settlements are not constrained to the COVID-19 pandemic (Abdulla, 2011; Nickanor, 2014; Rani et al., 2018; Khan & Flora, 2017). Without baseline data, we cannot make differentiations on the role that food and water security play on depression specifically during COVID-19 versus the role that they play more generally in urban informal settings.

Conclusions

COVID-19 created a large burden on psychological wellbeing globally, due to the stress of getting infected but also the lockdowns and their associated social and economic impacts (Hamadani et al., 2020; Kola et al., 2021). COVID-19 containment policies caused shut downs and delays in markets and supply chains, leading to a lack of economic opportunities, resource scarcity, and underemployment (Bau et al., 2021). Beyond resource scarcity, the social impacts of COVID-19 – isolation, stigma, mistrust, xenophobia – were profound and played a role in the global burden of poor mental health during COVID-19 (Akter et al., 2021; M. S. Islam et al., 2020; Santomauro et al., 2021).

Urban informal settlements were impacted uniquely by COVID-19, due to the inability to practice social distancing, the informal nature of employment, and other pre-existing environmental and social vulnerabilities (Corburn et al., 2020). There is reason to believe that these same vulnerabilities also placed individuals living in urban informal settlements at a higher risk of decreased psychological wellbeing. However, studies exploring the causal associations between COVID-19 and psychological wellbeing specifically in these settings are lacking, mostly due to the lack of baseline data on psychological wellbeing prior to COVID-19 in these contexts.

Prior research indicates that food and water insecurity do play a role in psychological wellbeing in urban informal settlements, both generally (Rani et al., 2018; Khan & Flora, 2017) and in the context of COVID-19 (Islam et al., 2020; Nyashanu, et al. 2020). Food insecurity's relationship has been more well-studied in these contexts, with multiple studies finding linkages between food insecurity and poor psychological wellbeing (Rani et al., 2018; Khan & Flora, 2017; Islam et al., 2020; Nyashanu, et al. 2020). Water insecurity, on the other hand, is a newer concept

in the academic literature and, therefore, has been less well studied (Bisung & Elliott, 2016b). In urban informal settlements, research on the relationships between water insecurity and wellbeing has been mostly limited to measurements of water-related emotional distress rather than the impact of water insecurity on overall psychological wellbeing (Akter et al. 2021; Kangmennaang et al., 2020; Wutich & Ragsdale, 2008).

For both food and water insecurity, the lack of baseline mental health data in COVID-related studies serves as a limitation for understanding the associations of mental health during COVID-19 and food and/or water insecurity. The Young Lives Study uses proxy indicators as a baseline to look at COVID-19 and psychological wellbeing, but the measurements used are different than those collected during COVID-19, and psychological wellbeing was only linked to food insecurity through qualitative anecdotes (Porter et al., 2021). To the author's knowledge, there is only one study published to date (Logie et al., 2022) that uses baseline data from prior to the pandemic to make a longitudinal comparison on how water and food insecurity specifically impact psychological wellbeing during COVID-19.

Furthermore, because research in urban informal settlements is already scant and due to the challenges of conducting research during the COVID-19 pandemic, there are geographical limitations in the literature that has been published thus far. No geographic area is extensively represented in the literature, and because urban informal settlements are so different depending on geography, culture, history, et cetera, it is hard to draw broader conclusions based on a small number of studies scattered throughout the world.

As urban informal settlements continue to grow and play an increasingly important role in terms of urbanization in the Global South, it is critical to understand what can be done to help

these environments and the people within them thrive, as outlined by SDG 11 (World Health Organization, UN-Habitat, 2016). Understanding how food and water insecurity can impact wellbeing during shocks and stressors such as COVID-19 can help inform urban policy and settlement upgrading initiatives, and more generally can provide insight into what factors strengthen resilience among residents of urban informal settlements in the face of adversity.

Methods

Overview

Using quantitative survey data collected from households in urban informal settlements in Makassar, Indonesia by researchers from the Revitalizing Informal Settlements and their Environments (RISE) trial, this longitudinal study seeks to determine whether household water and/or food insecurity influence self-reported psychological wellbeing among women living in urban informal settlements during the COVID-19 pandemic.

RISE is a randomized control trial currently being conducted in 24 urban informal settlements in Suva, Fiji and Makassar, Indonesia. In each city, six settlements have been randomized to the intervention arm, and six have been randomized to the control arm. In intervention settlements, RISE is collaborating with residents to design and build decentralized water and sanitation infrastructure at the household, neighborhood, and precinct level (Leder et al., 2021). Longitudinal assessments of health and wellbeing as well as human and environmental sampling will be used to assess the impact of the co-designed infrastructure on the trial's primary (reduced exposure to fecal contamination) and secondary (microbial contamination, ecological biodiversity, psychological wellbeing, to name a few) outcomes of interest (Leder et al., 2021). Additional details on the RISE trial can be found in the study protocol paper (Leder et al., 2021).

Study Population & Recruitment

The data for this survey was collected from 12 RISE intervention and control sites in Makassar, Indonesia. However, only 11 of the 12 RISE intervention communities are included in this study, as one of the sites only received responses from four households so that settlement

was subsequently dropped from analysis. At the times of data collection, intervention communities had been actively engaged in the infrastructure design process, but no infrastructure had been built in any of the RISE settlements.

RISE study settlements were chosen in consultation with local government officials, donors, research partners, communities, and other relevant stakeholders (Leder et al., 2021). Selection criteria for the settlement included both settlement-level characteristics (e.g. settlement size, clear physical boundaries from other settlements, experience of water stressors) and household characteristics (e.g. housing tenure, presence of children under the age of five years old) (Leder et al., 2021).

After settlements were selected, household recruitment was carried out by trained local community fieldworker teams (Leder et al., 2021). Recruitment for the purpose of assessment was at the household level. For the purpose of the RISE assessment, households are defined as one or more people who live in a shared house/dwelling and also share meals, living accommodation, and some household expenses. There can be more than one household living in one house. The teams attempted to recruit every household within the settlement boundaries, and obtained written informed consent from heads of households for participation in assessment activities such as surveys and sampling (Leder et al., 2021). Households also had the option of participating in the RISE intervention (e.g., participating in co-design workshops, connecting to water and sanitation infrastructure, etc.) without consenting to the assessment activities (Leder et al., 2021). Randomization to control and intervention groups occurred after baseline assessments using covariate-constrained randomization (Leder et al., 2021).

Recruitment strategies differed slightly for different surveys implemented within RISE. Data on psychological wellbeing was collected through in-person household surveys in November-December 2019 (T1) and phone surveys in February-March 2021 (T3). These surveys targeted the female head of household or housewife for answering household level questions. If they were not available, a female adult (defined as someone 18 years of age or older, or someone who is married or someone who has children) who lives in the house who could complete household level questions was requested. If a female adult was not present, any adult in the household who could answer household-level questions was requested. If none of those individuals were present, surveyors made arrangements to return when one of the requested individuals was available. During T1, a maximum of two household visitation attempts were made to survey each household. During T3, a maximum of three phone call attempts were made.

Data on food and water insecurity was collected in August-September 2020 (T2). For this survey, enumerators targeted two respondents per household: (1) the previous respondent (i.e., the respondent from the most recent prior survey) in order to enable comparisons across timepoints, and (2) another adult respondent in the same household of a different gender in order to enable intra-household comparisons by gender. If the previous respondent was not available after 3 call attempts, the enumerator requested to speak with "an adult who is able to answer questions about the health and activities of the whole household."

Demographic information was pulled from the baseline survey (T0), which was collected in November-December 2018. In the instances when baseline data was not available for a participant (i.e., the woman moved into the settlement after baseline data collection), demographic information was pulled from subsequent survey data.

Data Collection

The T1 and T3 household surveys focused on self-reported psychological wellbeing and associated indicators, including financial wellbeing and health symptoms. Psychological wellbeing was measured using questions from the Center for Epidemiological Studies Short Depression scale (Andresen et al., 1994a), also referred to as CESD-10. The CESD-10 is a ten question, shortened version of the twenty question Center for Epidemiological Studies Depression scale (Radloff, 1977). The questions ask the respondent to rate how often in the last week they've experienced certain depressive symptoms, scored between 0 (rarely or none of the time) and 3 (most or almost all of the time). Depressive symptoms included: trouble keeping your mind on what you are doing, feeling like everything you do is an effort, feeling fearful, and trouble sleeping. During the T3 data collection, the city of Makassar was in the "orange zone" regarding COVID-19 restrictions (COVID-19 Task Force, 2020) and was one of the biggest contributors to the COVID-19 case and death counts in Indonesia (Beech & Suhartono, 2021).

The T2 survey did not include psychological wellbeing but included questions on food and water security. Water security was measured using the short form of the Household Water Insecurity Experiences (HWISE) scale (Young, et al. 2021), known as the HWISE-4 (Young, Miller, et al., 2021). The HWISE-4 includes four questions on problems with water related to worry about having enough water to meet household needs, changing plans and schedule due to problems with water, access to drinking water, and access to water for handwashing. The HWISE-4 was validated using data from over 9,000 households in 25 low- and middle-income countries (Young, et al. 2021). Respondents scored how many times they had a specified water insecurity

experience in the past four weeks from the following options: never (0 times), rarely (1-2 times), sometimes (3-10 times), often (11-20 times), or always (more than 20 times).

Food security was measured using two questions drawn from Innovation for Poverty Action's Research for Effective COVID-19 Reponses (IPA RECOVR) survey (Egger, et al. 2021). The original IPA RECOVR survey was deployed in 9 countries to over 30,000 respondents (Egger, et al. 2021). In the original IPA RECOVR survey, the questions ask about how many days an individual experienced various food insecurity events within the past week, on a scale of 0 days to 7 days. For the purpose of this survey, the response options were modified to match the scale (never, rarely, sometimes, often, or always) and time frame (in the past four weeks) of the HWISE items. The modified food security items asked respondents to report how frequently in the past four weeks the respondent or someone in the respondent's household had to limit portion size at meals and how many times the respondent or someone in the respondent's household had to limit the number of meals eaten in a day.

T2 data collection occurred during the dry season in Makassar (Climate-Data.org, n.d.). During T2 data collection, Indonesia was the second largest contributor to COVID-19 cases in Southeast Asia, and South Sulawesi (the province where Makassar is located) was the fourth largest contributor to cases in Indonesia, following Jakarta and Java (WHO Indonesia, 2020). Indonesia also had an extremely high rate of COVID-19 mortality among children as compared to similar countries (WHO Indonesia, 2020). The city was still operating in the "Red Zone" of COVID-19 restrictions, but physical distancing had loosened as compared to two months prior (UNICEF, 2020a; UNICEF, 2020b).

Statistical Analysis

CESD-10 score was a sum of the 10 responses (Andresen et al., 1994). The highest possible score for the CESD-10 is 30. The higher the CESD-10 score, the more frequently the individual has experienced depressive symptoms (Andresen et al., 1994). The water insecurity score was determined by assigning a score of 0 to 'never,' 1 to 'rarely,' 2 to 'sometimes,' and 3 to both 'often' or 'always' and then summing across the four HWISE-4 items (Young, Miller, et al., 2021). The highest score that an individual can receive is 12. A household with a score greater than or equal to 4 is considered water insecure (Young, Miller, et al., 2021). Food insecurity was scored as a binary outcome whereby participants were considered to be food insecure if they ever (i.e., at least 'rarely') reported having reduced portion sizes or skipped meals in the past four weeks (Egger, et al. 2021). Water and food insecurity were also examined jointly; we created three categories for resource insecurity: "joint" (if a household had an HWISE score higher than 4 *AND* if participant ever reported having reduced portion sizes or skipped meals in the past four weeks), "one" (if a household had an HWISE score higher than 4 *OR* if participant ever reported having reduced portion sizes or skipped meals in the past four weeks), and "none" (if a household had an HWISE score lower than 4 *AND* if participant did not report having reduced portion sizes or skipped meals in the past four weeks).

Multivariate quantile regression models were used for analysis. The outcome of interest for this study was the CESD-10 score at T3. Three models were developed for analysis: one using self-reported household food insecurity as the primary predictor, one using self-reported household water insecurity as the primary predictor, and one that used joint food and water insecurity as the primary predictor. The model was adjusted to account for intervention status

and several covariates as described below, with clustered standard errors at the settlement level. The models looking at food insecurity and joint insecurity also included fixed effects at the settlement level to account for factors such as food environments and food supply chains (Heather Ohly et al., 2022). A sub-analysis of women who responded to both T1 and T3 surveys was conducted, controlling for CESD-10 score taken during T1. Data analysis was conducted using STATA 17.0.

Covariate Selection

The following variables were considered a priori as potential covariates due to their relationship with both the exposures (food and water insecurity) and the outcome (psychological wellbeing) based on prior literature (VanderWeele, 2019): intervention status, wealth (calculated based on household ownership of a variety of assets), disability (assessed using the Washington Group Short-Set on Functionality), and self-reported financial satisfaction (measured on an ordinal scale from 1-10, with a higher score indicating higher levels of satisfaction). Due to strong theoretical foundations and empirical evidence from other studies in favor of the importance between our selected covariates for psychological wellbeing, all covariates identified a priori were retained in the models except for intervention status. Because findings from the literature on the relationship between wealth and mental health in LMICs have been mixed (Lund et al., 2010), a sensitivity analysis was conducted removing the wealth variable.
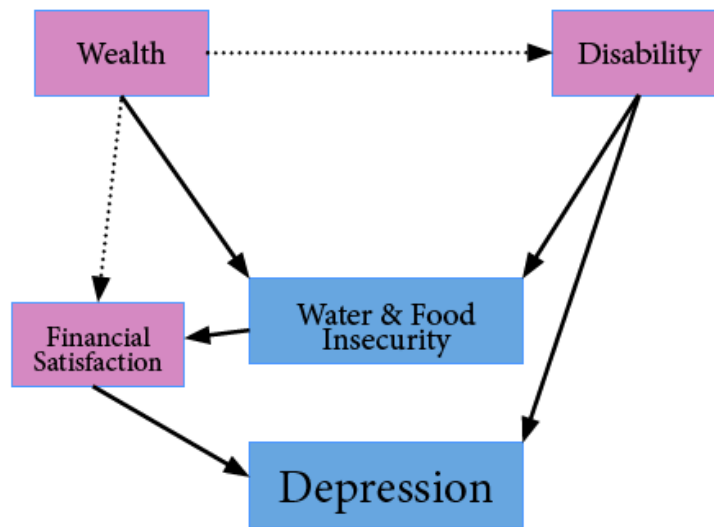
Figure 1: Directed Acyclical Graph demonstrating relationship between selected covariates (wealth, disability, financial satisfaction) and predictor (food and water insecurity) and outcomes variables (depression).

Ethics

This project was determined to be IRB-exempt as it is using secondary, de-identified data. RISE is led by Monash University and has ethics approval from the Monash University Human Research Ethics Committee (Melbourne, Australia; protocol 9396) and Universitas Hasanuddin (Makassar, Indonesia; protocol UH18020110). The RISE trial obtained informed consent from settlement leaders and community members for participation (Leder et al., 2021). During household data collection, survey field teams obtained informed consent from the head of household, and households were given the opportunity to withdraw consent or to consent to participate in future RISE activities (if they refused consent prior) during each survey period (Leder et al., 2021).

Results

Descriptive Analysis

Table 1 provides descriptive statistics of the analytic sample (N=323). The average age of women in the study was approximately 40 years old. Of the 323 women, over 85% were married and the largest percentage had a primary school level of education (39.9%). The majority ethnicity (66.9%) was Makassarese and majority religion (92.3%) was Muslim. Four percent of the study participants reported living with a disability. When asked at T3 about their satisfaction with their current financial situation, the mean response was 5.8 on a scale of 1-10, with a higher score indicating higher levels of satisfaction.

Table 1. Demographic Characteristics (N=323)

Variable	N or Mean	% or SD (Min-Max)
Age	40.62	11.39 (19.5 – 78.17)
Marital Status		
Single/Never Married	17	5.3%
Married	280	86.7%
Divorced	9	2.8%
Separated	3	0.9%
Widowed	14	4.3%
Wealth Quintiles		
Lowest	85	23.3%
Second lowest	54	16.7%
Middle	46	14.2%
Second highest	52	16.1%
Highest	86	26.6%
Highest Level of Schooling Completed		
Never attended	13	4%
Primary school	129	39.9%
Junior high school	73	22.6%
Senior high school	94	29.1%
Academy/Trade School	3	0.9%
University	9	2.8%
Missing	2	0.6%
Ethnicity		
Makassarese	216	69.5%
Other	95	30.6%

Religion		
Muslim	292	92.3%
Other	11	3.4%
Missing	14	4.3%
Living with Disability	13	4%
Self-Reported Financial Satisfaction	5.8	1.85 (1-10)
Missing observations: 2 observations (0.62%) missing from highest level of schooling completed 12 observations (3.72%) missing from ethnicity 14 observations (4.33%) missing from religion		

Table 2 and Figures 2-4 present descriptive statistics for key outcome and predictor variables of interest. The mean CESD-10 score during the pandemic was 4.33, and the highest score reported was 23 (out of a total possible score of 30) (Figure 2). The mean HWISE-4 score among households was 1.34, with the highest reported score being 12 (out of a total possible score of 12). Figure 3 shows the distribution of responses to the HWISE-4 questions. Just above 17% of households were classified as "water insecure" based on HWISE-4 guidelines. Approximately 20% of households were classified as food insecure. Figure 4 demonstrates the distribution of responses to the IPA RECOVR questions measuring food insecurity.

**Table 2. Descriptive statistics of key variables of interest (N=323)**

Variable	N or Mean	% or SD (Min-Max)
Psychological Wellbeing		
CESD-10 Score Pre-Pandemic (mean)	4.05	3.13 (0 – 17)
CESD-10 Score During Pandemic (mean)	4.33	2.98 (0 – 23)
Resource Insecurity		
Water Insecurity		
Water Secure (count)	265	82%
Water Insecure (count)	58	17.9%
HWISE Score (mean)	1.34	2.3 (0 - 12)
Food Insecurity		
Food secure (count)	255	78.9%
Food insecure (count)	65	20.1%
Joint Insecurity		
Both (count)	21	6.5%
Either food or water (count)	81	25%
Neither (count)	218	67.5%
At least one (count)	102	31.5%
Missing observations: 102 (31.58%) missing from CESD-10 score pre-pandemic 3 (0.93%) missing from food insecurity 3 (0.93%) missing from joint insecurity		
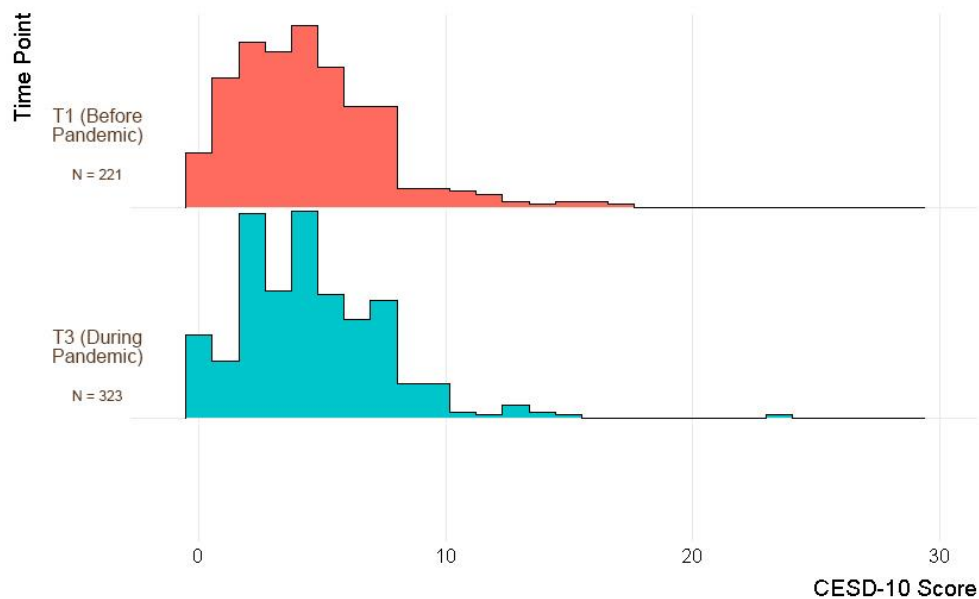
Figure 2: Distribution of CESD-10 scores at T1 (N=221) and T3 (N=323).
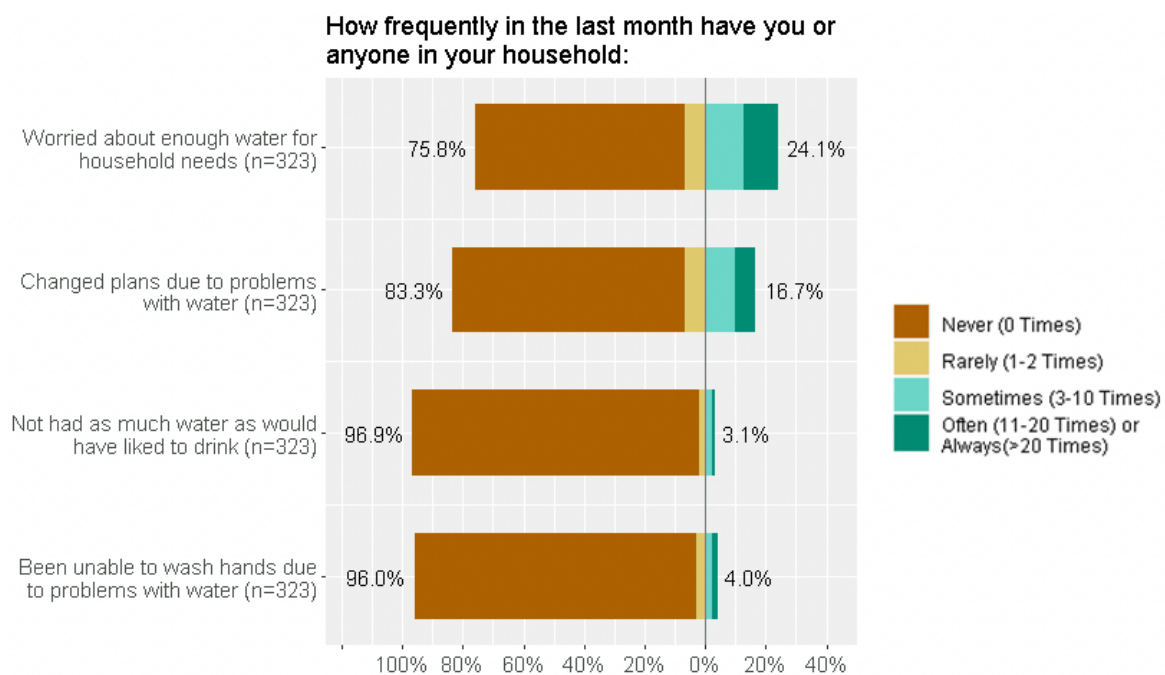
Figure 3: Distribution of responses to HWISE questions.
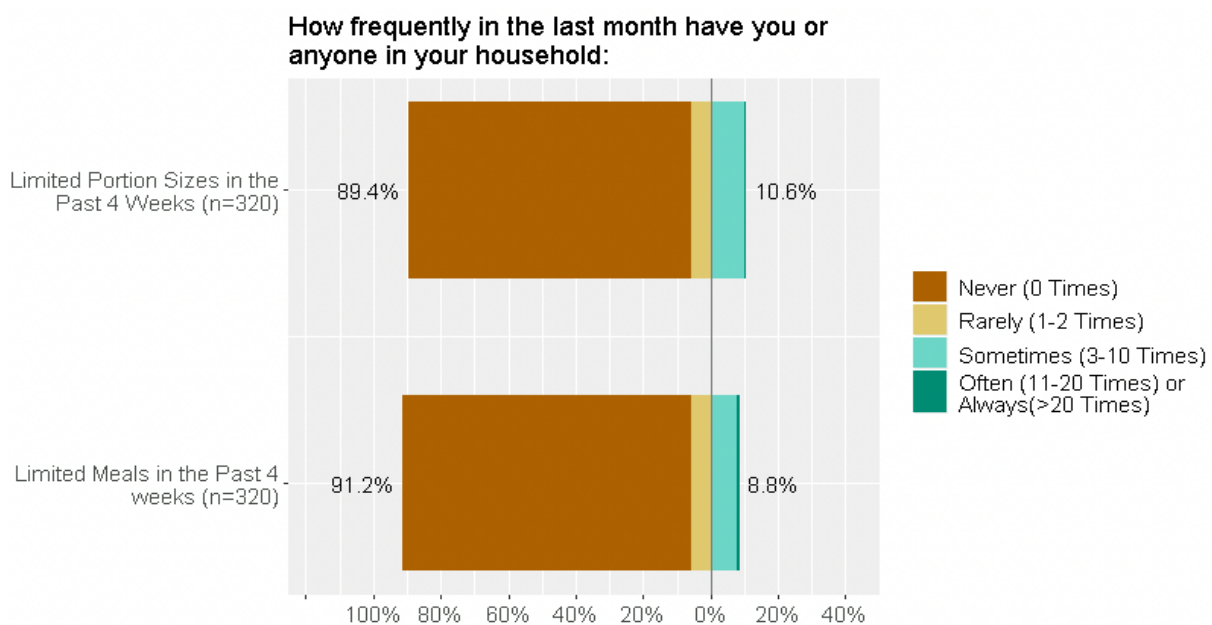
Figure 4: Distribution of responses to experiences of household food insecurity.

Bivariate Analysis

Table 3 shows results of bivariate analyses between each independent variable and CESD-10 score. Bivariate analysis suggested a positive but not statistically significant relationship between water insecurity and CESD-10 score during the COVID-19 pandemic (B: 0.14, P: 0.094, CI: -0.02 – 0.31). The relationship between food insecurity and CESD-10 score was also positive and was statistically significant (B: 1.66, P: 0.001, CI: 0.65 - 2.66). Joint insecurity had a stronger, statistically significant positive relationship with CESD-10 score (B: 2.37, P: 0.005, CI: 0.71 – 4.07).

In other bivariate analyses, psychological wellbeing prior to the COVID-19 pandemic (B: 2.7, P<0.001, CI: 0.15 – 0.40) and financial satisfaction (B: -0.17, P: 0.004, CI: -0.33 - -0.01) displayed a statistically significant association with psychological wellbeing during COVID. Due to strong theoretical foundations and empirical evidence from other studies in favor of the importance of our selected covariates for psychological wellbeing, all covariates identified a priori were retained in subsequent models. Because the data come from a randomized controlled trial, we also checked whether intervention status had any observable relationship with the key outcome of interest, but analysis found no effect and, therefore, intervention status was not included in the models. In a t-test examining the differences between CESD-10 score prior to and during the COVID-19 pandemic, there was no statistically significant difference (μ (diff)= 0.25, t: 1.07, CI: -0.21 – 0.71).

Table 3. Bivariate Analysis with CESD-10 Score During Pandemic (N=323)

Variable	B	95% CI	p-value
Resource Security			
Water Insecurity	0.14	-0.02 – 0.31	0.094
Food Insecurity	1.66	0.65 – 2.66	0.001
Food & Water Insecurity	2.37	0.71 – 4.07	0.005
Respondent Characteristics			
CESD-10 Score at T1	0.27	0.15 – 0.4	<0.001
Wealth	-0.09	-0.3 – 0.11	0.381
Disability	1.57	-0.53 – 3.67	0.143
Intervention Status	0.001	-0.61 - 0.61	0.996
Financial Satisfaction	-0.17	-0.33 - -0.01	0.004
Missing observations: 102 (31.58%) missing from CESD-10 score pre-pandemic 3 (0.93%) missing from food insecurity 3 (0.93%) missing from joint insecurity			

Multivariate Analysis

Table 4 shows the results of multivariate analyses between the predictor variables (food insecurity, water insecurity, and joint food and water insecurity) with CESD-10 score. The first model adjusted for wealth, disability, and financial satisfaction. A sub-analysis adjusted for all covariates (wealth, disability, financial satisfaction, and pre-pandemic CESD-10 score). The final model was a sensitivity analysis adjusting for all covariates except for wealth.

Water Insecurity

A model with the full sample size (N=323) and adjusted for wealth, disability, financial satisfaction, and clustering at the settlement level indicated that water insecurity was positively associated with CESD-10 score, though the result was not statistically significant (B: 0.13, P: 0.07, CI: - 0.01 – 0.26). In models that additionally adjusted for CESD-10 score at T1 (N=221), results

were similar (B: 0.12, P: 0.186, CI: -0.06 – 0.3). Removing wealth as a covariate had no change on the effect of water insecurity on CESD-10 score (B: 0.12, P: 0.19, CI: -0.06 – 0.3).

Food Insecurity

Before adjusting for CESD-10 score at T1, a model (N=320) with clustering and fixed effects at the settlement level indicated a statistically significant positive relationship between food insecurity and CESD-10 score (B: 1.48, CI: 0.79 – 2.17, P<0.001). However, in the sub-analysis (N=218) adjusting for CESD-10 score at T1, the relationship between food insecurity and CESD-10 score was attenuated and no longer statistically significant (B: 0.95, CI: -0.37 – 2.26, P: 0.157). As with water insecurity, a sensitivity analysis excluding wealth as a covariate did not have a meaningful change on the effect of food insecurity on psychological wellbeing (B: 0.96, CI: -0.3 – 2.22, p: 0.137)

Joint Food & Water Insecurity

A final analysis was conducted examining the psychological wellbeing effects of joint food and water insecurity as compared to one or no resource insecurity. A model including all covariates (wealth, disability, and financial satisfaction) with clustering and fixed effects at the settlement level showed a statistically significant positive relationship between joint food and water insecurity and CESD-10 score (B: 2.40, P<0.001, CI: 1.43-3.38). When adjusting for CESD-10 score at T1, joint insecurity maintained strong and statistically significant associations with CESD-10 score during COVID-19 (B: 1.96, P: 0.001, CI: 0.78-3.15). A sensitivity analysis removing wealth

score from the regression had no influence on the effects of joint resource insecurity on psychological wellbeing (B: 1.97, P: 0.001, CI: 0.8 – 3.14).

Table 4. Multivariate Regression Results

Model	N	B	95% CI	P-Value
Water Insecurity				
Adjusted for wealth, disability, and financial situation	323	0.13	-0.01 – 0.26	0.07
Adjusted for all covariates (including pre-COVID-CESD-10)	221	0.12	-0.06 – 0.3	0.186
Adjusted for all covariates WITHOUT wealth	221	0.12	-0.06 – 0.3	0.19
Food Insecurity				
Adjusted for wealth, disability, financial situation	320	1.48	0.79 – 2.17	0.000
Adjusted for all covariates (including pre-COVID-CESD-10)	218	0.95	-0.37 – 2.26	0.157
Adjusted for all covariates WITHOUT wealth	218	0.96	-0.3 – 2.22	0.137
Joint Water and Food Insecurity				
Adjusted for wealth, disability, financial situation	320	2.4	1.43 – 3.38	0.000
Adjusted for all covariates (including pre-COVID-CESD-10)	218	1.96	0.78 – 3.15	0.001
Adjusted for all covariates WITHOUT wealth	218	1.97	0.8 – 3.14	0.001
Missing observations: 102 (31.58%) missing from CESD-10 score pre-pandemic 3 (0.93%) missing from food insecurity 3 (0.93%) missing from joint insecurity				

Discussion

As the only longitudinal study to the author's knowledge that examines relationships between food and water insecurity and women's psychological wellbeing in urban informal settlements during the COVID-19 pandemic, this study contributes to the understanding of how resource insecurity may influence the wellbeing of women living in urban informal settlements during shocks and stressors. About 30% of the women reported facing at least one type of resource insecurity, and 6.5% of the women reported facing both water and food insecurity. When analyzed together, joint food and water insecurity had a strong and statistically significant relationship with psychological wellbeing as compared to having just one or no resource insecurity, even after controlling for pre-pandemic wellbeing. This corroborates past research in urban informal settlements that finds high reports of household food and water insecurity (Adams, 2017; Adams et al., 2020; Joshi et al., 2019; Naicker et al., 2015). It also aligns with prior research that suggests that joint food and water insecurity compound the individual effects of one or the other (Miller, Frongillo, et al., 2021; Schuster et al., 2020).

Water and food insecurity are not a mutually exclusive experience (Miller et al., 2021). Water insecurity is complex and has been found to have a strong influence on food insecurity, through food production and preparation (Miller, Workman, et al., 2021; Varis et al., 2017). For this reason, it may be most appropriate to analyze food and water insecurity in conjunction, rather than as two separate experiences.

The COVID-19 pandemic appeared to have a negligible influence on women's self-reported psychological wellbeing as measured by CESD-10 score. A longitudinal study conducted on the impact of COVID-19 on the psychological wellbeing of refugee youth living in urban

informal settlements in Kampala, Uganda had similar findings (Logie et al., 2022). A possible

explanation for this finding, which is counter to much of the literature that found negative and

significant impacts of COVID-19 on mental health in LMICs (Egger et al., 2021; Hamadani et al.,

2020; Porter et al., 2021; Serafini et al., 2020), is that living in an urban informal settlement

presents a multitude of day-to-day challenges, for which individuals living in these settings have

already developed coping mechanisms (Logie et al., 2022).

Prior to adjusting for pre-pandemic wellbeing, food insecurity had statistically significant

associations with CESD-10 score, indicating a potential relationship between resource insecurity

and psychological wellbeing. However, after adjusting for pre-pandemic psychological wellbeing,

these relationships were still positive but were no longer statistically significant. One possible

explanation for this is that individuals facing food insecurity during the COVID-19 pandemic were

already at a heightened risk for or already facing food insecurity prior to the pandemic so the

mental health impacts of resource insecurity already existed. However, since there is no pre-

pandemic data available for food or water insecurity, it is not possible to test this hypothesis.

Water insecurity had positive (but not statistically significant) associations with CESD-10

score both prior to and after adjusting for pre-pandemic wellbeing, which contradicts some of

the literature that finds significant associations between water insecurity and mental health in

LMICs (Brewis et al., 2019; Wutich et al., 2020). This is the first study on psychological wellbeing

and water insecurity in LMICs that uses CESD-10 score as a measurement for psychological

wellbeing (Wutich et al., 2020), which may be an explanation for the deviation in findings.

Another possible explanation for this could be the effects of seasonality on the data collection.

Water insecurity data was collected during the dry season in Makassar, while CESD-10 score was

collected during the rainy season. Research has shown that seasonality affects water insecurity in both Makassar and globally (Danielaini et al., 2019; Grasham et al., 2019; Singh et al., 2021), so the timing of data collection may have influenced the outcome. Furthermore, while nearly 20% of respondents were classified as water insecure, more than 60% of the population reported no experiences of water insecurity at all (i.e., HWISE scores equal to 0) in the past month. It is possible that the distribution of these results may have made it challenging to detect a relationship between water insecurity and CESD-10 score.

Another potential explanation for the null findings in both the food and water insecurity regressions is the small sample size and issues with number of clusters in the RISE trial, which is discussed further in the strengths and limitations. The sample size in RISE was pre-determined by the number of households in the settlements and calculated to detect an effect on the trial's primary health outcomes assessed in children under 5 rather than the outcomes assessed here (Leder et al., 2021).

Strengths and Limitations

This study had several strengths. One of the primary strengths is the inclusion of data on both food and water insecurity, as well as data on psychological wellbeing from timepoints before and during the COVID-19 pandemic. Several studies explore the relationship between resource insecurity and psychological wellbeing during the COVID-19 pandemic (S. M. D.-U. Islam et al., 2020; Nyashanu et al., 2020; Santana et al., 2021), but we identified that a major gap in the existing literature was the virtual absence of metrics representing 'baseline' psychological wellbeing, which are necessary in order to draw conclusions about causality. To the author's

knowledge, this is only the second study on psychological wellbeing during COVID-19 in urban

informal settlements that utilizes pre-pandemic psychological wellbeing data and is the first that

does so specifically for women. Moreover, this is one of very few studies looking at the impacts

of COVID-19 in urban informal settlements and the first looking specifically at food and water

insecurity. This study is also the first to focus on these topics in Indonesia, expanding the

geographical reach of research in urban informal settlements. Finally, the methodologies for

measuring psychological wellbeing, food insecurity, and water insecurity were all grounded in

prior research. The HWISE-4 survey tool has been validated in multiple LMICs, including Indonesia

(Young et al., 2021). The CESD-10 and IPA RECOVR survey have been used successfully in a swath

of LMICs, including in East Asia and the Pacific (Egger et al., 2021; Mackinnon et al., 1998;

Tampubolon & Hanandita, 2014).

There are several limitations in this study as well. RISE collects data at the household level,

which means that different household members may respond to different survey waves. Many

survey participants who responded to the CESD-10 questionnaire during T1 were not available or

did not respond during the household surveys in T3, meaning that there was no baseline

psychological wellbeing data available for approximately one-third of the original sample. While

this limited our sample size and thus statistical power for the pre-pandemic CESD-10 adjusted

models, our decision and ability to match pre- and post-pandemic CESD-10 scores at the

individual (rather than the household) level was a substantial strength in terms of the study's

internal validity. Furthermore, due to the COVID-19 pandemic, surveys were conducted via

phone rather than face-to-face, which may have impacted how participants responded to the

survey questions, although feedback from RISE participants suggested that women may have been more comfortable talking about sensitive subjects over the phone rather than face-to-face.

Another limitation is that T2 was the first time that the RISE study used the HWISE-4 or the IPA RECOVR questions on food insecurity. For this reason, there was no information available on baseline food or water security prior to the COVID-19 pandemic, therefore leaving out a potentially valuable piece of information on how change in food or water security subsequently influenced change in psychological wellbeing. Finally, the clustered nature of the RISE trial calls for consideration of clustered effects in data analysis, yet 11 clusters may be problematic for statistical power and therefore clustering at the settlement level may have obscured the effects of food and water insecurity on psychological wellbeing (McNeish & Stapleton, 2016).

Public Health Implications

These findings have important implications for practitioners working on global health, urban planning, resilience, and other areas related to urban informal settlements or at the nexus of food security, water security, and health or development.

Globally, poor psychological wellbeing, such as heightened stress or depression, is associated with premature mortality and hinders social progress, human capital, and individual potential (Herrman et al., 2019; Patel et al., 2016). While the nutritional and infectious disease implications of food and water insecurity are well-documented and recognized in the field of global public health (Adams et al., 2020; Boliko, 2019; Ivers & Cullen, 2011; Poulsen et al., 2015; Schuster et al., 2020), the impacts on psychological wellbeing have been less well-documented (Adams et al., 2020; Pourmotabbed et al., 2020; Wutich et al., 2020). Understanding these

pathways in urban informal settlements, where data is scant, may be particularly important as informal settlements continue to play a pivotal role in urbanization (UN-Habitat, 2015). In Makassar specifically, 67% of the housing growth has occurred in urban informal settlements in the past ten years, and population growth projections show that the city will continue to expand rapidly in the next 20 years due to urban migration (ASEAN Australia Smart Cities Trust Fund, 2021).

In terms of global public health practice, the findings of this study underline the importance of addressing food and water insecurity together, rather than in silos as is standard practice. Currently the SDGs call for addressing both food and water insecurity in separate goals, but fail to acknowledge their complex and important inter-relationship (Ringler, C. et al., 2018; Varis et al., 2017; Young, Frongillo, et al., 2021). Coordination between the water, sanitation and hygiene (WASH) and nutrition sectors may be vital for delivering effective interventions that reflect the complexity of their beneficiaries' lived experiences (Ringler & Paulo, 2020). Moving forward, global health practitioners should reconsider the approach of food and water insecurity as separate experiences and design interventions and policies that both acknowledge and address their relationships. This consideration is important for urban informal settlements, where there may be both limited or inconsistent access to WASH infrastructure and disrupted food environments/food supply chains (Sverdlik, 2011). World Vision's piped water intervention in Zambia is a good example of how an intervention could potentially address both water and food insecurity. Researchers found that increasing access to piped water also increased household gardens as well as garden size (Winter et al., 2021). Theoretically, household gardens can aid in decreasing household food insecurity by increasing availability and accessibility of

nutritious foods (Galhena et al., 2013). However, food insecurity was not a main focus of the World Vision intervention, nutrition outcomes were not measured, and the intervention took place in rural areas, limiting its generalizability to urban informal settlements (Winter et al., 2021). To the author's knowledge, there are currently no interventions or programs that jointly address water and food insecurity directly as primary outcomes, which underlines the importance of rethinking how we approach food and water insecurity policy and practice (Young, Frongillo, et al., 2021).

The findings of this study have important implications for women, who are often the primary caregivers in the household and therefore may be more susceptible to the effects of both resource insecurity and of shocks and stressors such as the COVID-19 pandemic on wellbeing (Angwenyi et al., 2021; Oldewage-Theron & Kruger, 2011). More often than not, women bear the burden of household duties such as water collection, cooking, and infant and young child feeding, all of which depend on access to water and food sources, resulting in a disproportionate burden of the effects of food and water insecurity on women's time and energy (Madzorera & Fawzi, 2020; Ray, 2007). While there have been concerted efforts recently to mainstream gender into WASH and nutrition research and programming (Brody et al., 2015; Madzorera & Fawzi, 2020; Packett et al., 2020; Pouramin et al., 2020), these efforts will be stymied if the relationship between and effects of these insecurities on women's wellbeing are not considered.

Works Cited

Abdulla, A. I. S. (2011). *Food insecurity in urban informal settlements: A case study of Kibera,*

    Nairobi [Thesis, The University of Nairobi].

    http://erepository.uonbi.ac.ke/handle/11295/11088

Adams, E. A. (2017). Thirsty slums in African cities: Household water insecurity in urban

    informal settlements of Lilongwe, Malawi. *International Journal of Water Resources*

    Development. https://www-tandfonline-

    com.proxy.library.emory.edu/doi/abs/10.1080/07900627.2017.1322941

Adams, E. A., Stoler, J., & Adams, Y. (2020). Water insecurity and urban poverty in the Global

    South: Implications for health and human biology. *American Journal of Human Biology*,

    32(1), e23368. https://doi.org/10.1002/ajhb.23368

Akbar, P. N. G., & Edelenbos, J. (2020). Social Impacts of Place-Making in Urban Informal

    Settlements: A Case Study of Indonesian Kampungs. *Social Sciences*, *9*(6), 104.

    https://doi.org/10.3390/socsci9060104

Akter, R., Akter, M., Hossain, Md. T., & Ahsan, Md. N. (2021). Chapter5—Socio-environmental

    factors affecting mental health of people during Covid-19 in coastal urban areas of

    Bangladesh. In A. L. Ramanathan, C. Sabarathinam, F. Arriola, M. V. Prasanna, P. Kumar,

    & M. P. Jonathan (Eds.), *Environmental Resilience and Transformation in Times of*

    COVID-19 (pp. 49–62). Elsevier. https://doi.org/10.1016/B978-0-323-85512-9.00011-5

Andrade, C. (2020). The Limitations of Online Surveys. *Indian Journal of Psychological Medicine*,

    42(6), 575–576. https://doi.org/10.1177/0253717620957496

Andresen, E. M., Malmgren, J. A., Carter, W. B., & Patrick, D. L. (1994a). Screening for

    Depression in Well Older Adults: Evaluation of a Short Form of the CES-D. *American*

    Journal of Preventive Medicine, *10*(2), 77–84. https://doi.org/10.1016/S0749-

    3797(18)30622-6

Andresen, E. M., Malmgren, J. A., Carter, W. B., & Patrick, D. L. (1994b). Screening for

    depression in well older adults: Evaluation of a short form of the CES-D (Center for

    Epidemiologic Studies Depression Scale). *American Journal of Preventive Medicine*,

    10(2), 77–84.

Angwenyi, V., Kabue, M., Chongwo, E., Mabrouk, A., Too, E. K., Odhiambo, R., Nasambu, C.,

    Marangu, J., Ssewanyana, D., Njoroge, E., Ombech, E., Mokaya, M. M., Obulemire, E. K.,

    Khamis, A., & Abubakar, A. (2021). Mental Health during COVID-19 Pandemic among

    Caregivers of Young Children in Kenya's Urban Informal Settlements. A Cross-Sectional

    Telephone Survey. *International Journal of Environmental Research and Public Health*,

    18(19), 10092. https://doi.org/10.3390/ijerph181910092

ASEAN Australia Smart Cities Trust Fund. (2021). *Makassar Livable City Plan: Situation*

    Assessment Report. 149.

Barnett, I., Ariana, P., Petrou, S., Penny, M. E., Duc, L. T., Galab, S., Woldehanna, T., Escobal, J.

    A., Plugge, E., & Boyden, J. (2013). Cohort Profile: The Young Lives Study. *International*

    Journal of Epidemiology, *42*(3), 701–708. https://doi.org/10.1093/ije/dys082

Bau, N., Khanna, G., Low, C., Shah, M., Sharmin, S., & Voena, A. (2021). *Women's Well-Being*

    During a Pandemic and its Containment (Working Paper No. 29121; Working Paper

    Series). National Bureau of Economic Research. https://doi.org/10.3386/w29121

Beech, H., & Suhartono, M. (2021, March). 'It's Too Late': In Sprawling Indonesia, Coronavirus

Surges. *The New York Times*.

https://www.nytimes.com/2020/05/28/world/asia/indonesia-coronavirus-surge.html

Bird, P., Omar, M., Doku, V., Lund, C., Nsereko, J. R., Mwanza, J., & the MHaPP Research

Programme Consortium. (2011). Increasing the priority of mental health in Africa:

Findings from qualitative research in Ghana, South Africa, Uganda and Zambia. *Health*

Policy and Planning, *26*(5), 357–365. https://doi.org/10.1093/heapol/czq078

Bisung, E., & Elliott, S. (2016a). *'Everyone is exhausted and frustrated': Exploring psychosocial*

impacts of the lack of access to safe water and adequate sanitation in Usoma, Kenya.

https://doi.org/10.2166/WASHDEV.2016.122

Bisung, E., & Elliott, S. J. (2016b). Psychosocial impacts of the lack of access to water and

sanitation in low- and middle-income countries: A scoping review. *Journal of Water and*

Health, *15*(1), 17–30. https://doi.org/10.2166/wh.2016.158

Black, R., Bennett, S. R. G., Thomas, S. M., & Beddington, J. R. (2011). Migration as adaptation.

Nature, *478*(7370), 447–449. https://doi.org/10.1038/478477a

Boliko, M. C. (2019). FAO and the Situation of Food Security and Nutrition in the World. *Journal*

of Nutritional Science and Vitaminology, *65*(Supplement), S4–S8.

https://doi.org/10.3177/jnsv.65.S4

Brewis, A., Choudhary, N., & Wutich, A. (2019). Household water insecurity may influence

common mental disorders directly and indirectly through multiple pathways: Evidence

from Haiti. *Social Science & Medicine (1982)*, *238*, 112520.

https://doi.org/10.1016/j.socscimed.2019.112520

Brody, A., Hossain, N., Oswald, K., & Smith, S. (2015). *Innovations from the Field: Gender mainstreaming from the ground up for the World Food Programme*. https://opendocs.ids.ac.uk/opendocs/handle/20.500.12413/7089

Carias, M. E., Johnston, D., Knott, R., & Sweeney, R. (2021). Flood Disasters and Health Among the Urban Poor. *ArXiv:2111.05455 [Econ, q-Fin]*. http://arxiv.org/abs/2111.05455

Carpenter, J. P., Daniere, A. G., & Takahashi, L. M. (2004). Cooperation, trust, and social capital in Southeast Asian urban slums. *Journal of Economic Behavior & Organization*, *55*(4), 533–551. https://doi.org/10.1016/j.jebo.2003.11.007

Corburn, J., Vlahov, D., Mberu, B., Riley, L., Caiaffa, W. T., Rashid, S. F., Ko, A., Patel, S., Jukur, S., Martínez-Herrera, E., Jayasinghe, S., Agarwal, S., Nguendo-Yongsi, B., Weru, J., Ouma, S., Edmundo, K., Oni, T., & Ayad, H. (2020). Slum Health: Arresting COVID-19 and Improving Well-Being in Urban Informal Settlements. *Journal of Urban Health*, *97*(3), 348–357. https://doi.org/10.1007/s11524-020-00438-6

COVID-19 Task Force. (2020, October 6). *Improved Handling of COVID-19 in East Java and South Sulawesi, Successfully Out of the Red Zone | Covid19.go.id*. https://covid19.go.id/p/berita/peningkatan-penanganan-covid-19-di-jawa-timur-dan-sulawesi-selatan-berhasil-keluar-dari-zona-merah

Danielaini, T. T., Maheshwari, B., & Hagare, D. (2019). An assessment of household water insecurity in a rapidly developing coastal metropolitan region of Indonesia. *Sustainable Cities and Society*, *46*, 101382. https://doi.org/10.1016/j.scs.2018.12.010

Daruwalla, N., Kanougiya, S., Gupta, A., Gram, L., & Osrin, D. (2020). Prevalence of domestic violence against women in informal settlements in Mumbai, India: A cross-sectional survey. *BMJ Open*, *10*(12). https://bmjopen.bmj.com/content/10/12/e042444.abstract

De Sousa, A., Mohandas, E., & Javed, A. (2020). Psychological interventions during COVID-19: Challenges for low and middle income countries. *Asian Journal of Psychiatry*, *51*, 102128. https://doi.org/10.1016/j.ajp.2020.102128

Egger, D., Miguel, E., Warren, S. S., Shenoy, A., Collins, E., Karlan, D., Parkerson, D., Mobarak, A. M., Fink, G., Udry, C., Walker, M., Haushofer, J., Larreboure, M., Athey, S., Lopez-Pena, P., Benhachmi, S., Humphreys, M., Lowe, L., Meriggi, N. F., … Vernot, C. (2021). Falling living standards during the COVID-19 crisis: Quantitative evidence from nine developing countries. *Science Advances*, *7*(6), eabe0997. https://doi.org/10.1126/sciadv.abe0997

Elgar, F. J., Pickett, W., Pförtner, T.-K., Gariépy, G., Gordon, D., Georgiades, K., Davison, C., Hammami, N., MacNeil, A. H., Azevedo Da Silva, M., & Melgar-Quiñonez, H. R. (2021). Relative food insecurity, mental health and wellbeing in 160 countries. *Social Science & Medicine*, *268*, 113556. https://doi.org/10.1016/j.socscimed.2020.113556

Ennis-McMillan, M. C. (2001). Suffering from Water: Social Origins of Bodily Distress in a Mexican Community. *Medical Anthropology Quarterly*, *15*(3), 368–390.

Ezeh, A., Oyebode, O., Satterthwaite, D., Chen, Y.-F., Ndugwa, R., Sartori, J., Mberu, B., Melendez-Torres, G. J., Haregu, T., Watson, S. I., Caiaffa, W., Capon, A., & Lilford, R. J. (2017). The history, geography, and sociology of slums and the health problems of people who live in slums. *The Lancet*, *389*(10068), 547–558. https://doi.org/10.1016/S0140-6736(16)31650-6

Fahim, S. M., Gazi, M. A., Hasan, M. M., Alam, M. A., Das, S., Mahfuz, M., Rahman, M. M., Haque, R., Sarker, S. A., & Ahmed, T. (2021). Infection with Blastocystis spp. And its association with enteric infections and environmental enteric dysfunction among slum-dwelling malnourished adults in Bangladesh. *PLOS Neglected Tropical Diseases*, *15*(8), e0009684. https://doi.org/10.1371/journal.pntd.0009684

Galhena, D. H., Freed, R., & Maredia, K. M. (2013). Home gardens: A promising approach to enhance household food security and wellbeing. *Agriculture & Food Security*, *2*(1), 8. https://doi.org/10.1186/2048-7010-2-8

Gibbs, A., Jewkes, R., Willan, S., & Washington, L. (2018). Associations between poverty, mental health and substance use, gender power, and intimate partner violence amongst young (18-30) women and men in urban informal settlements in South Africa: A cross-sectional study and structural equation model. *PLOS ONE*, *13*(10), e0204956. https://doi.org/10.1371/journal.pone.0204956

Grasham, C. F., Korzenevica, M., & Charles, K. J. (2019). On considering climate resilience in urban water security: A review of the vulnerability of the urban poor in sub-Saharan Africa. *WIREs Water*, *6*(3), e1344. https://doi.org/10.1002/wat2.1344

Greif, M. J., & Nii-Amoo Dodoo, F. (2015a). How community physical, structural, and social stressors relate to mental health in the urban slums of Accra, Ghana. *Health & Place*, *33*, 57–66. https://doi.org/10.1016/j.healthplace.2015.02.002

Greif, M. J., & Nii-Amoo Dodoo, F. (2015b). How community physical, structural, and social stressors relate to mental health in the urban slums of Accra, Ghana. *Health & Place*, *33*, 57–66. https://doi.org/10.1016/j.healthplace.2015.02.002

Gruebner, O., Khan, M. H., Lautenbach, S., Müller, D., Kraemer, A., Lakes, T., & Hostert, P.

 (2011). A spatial epidemiological analysis of self-rated mental health in the slums of

 Dhaka. *International Journal of Health Geographics*, *10*(1), 36.

 https://doi.org/10.1186/1476-072X-10-36

Gruebner, O., Khan, M. M. H., Lautenbach, S., Müller, D., Krämer, A., Lakes, T., & Hostert, P.

 (2012). Mental health in the slums of Dhaka—A geoepidemiological study. *BMC Public*

 Health, *12*(1), 177. https://doi.org/10.1186/1471-2458-12-177

Gumelar, G., Vania, A., & Maulana, H. (2018). Do Cultural Styles Predict Pro-Environment

 Behaviour among Slum-area Resident of Jakarta? *E3S Web of Conferences*, *68*, 02003.

 https://doi.org/10.1051/e3sconf/20186802003

Hamadani, J. D., Hasan, M. I., Baldi, A. J., Hossain, S. J., Shiraji, S., Bhuiyan, M. S. A., Mehrin, S.

 F., Fisher, J., Tofail, F., Tipu, S. M. M. U., Grantham-McGregor, S., Biggs, B.-A., Braat, S.,

 & Pasricha, S.-R. (2020). Immediate impact of stay-at-home orders to control COVID-19

 transmission on socioeconomic conditions, food insecurity, mental health, and intimate

 partner violence in Bangladeshi women and their families: An interrupted time series.

 The Lancet Global Health, *8*(11), e1380–e1389. https://doi.org/10.1016/S2214-

 109X(20)30366-1

Heather Ohly, Martyn Clark, Sonja Read, Severine Frison, & Sophie Goudet. (2022). *Food*

 security and diets in urban Asia: How resilient are food systems in times of Covid 19?

 World Food Programme, Dikoda.

Herrman, H., Kieling, C., McGorry, P., Horton, R., Sargent, J., & Patel, V. (2019). Reducing the

global burden of depression: A Lancet–World Psychiatric Association Commission. *The*

Lancet, *393*(10189), e42–e43. https://doi.org/10.1016/S0140-6736(18)32408-5

Islam, M. S., Rahman, M. E., Banik, R., Emran, M. G. I., Saiara, N., Hossain, S., Hasan, M. T.,

Sikder, M. T., Smith, L., & Potenza, M. N. (2020). *Correlates of Financial Concerns and*

Symptoms of Depression and Posttraumatic Stress Disorder in Impoverished Urban-

dwelling Individuals in Bangladesh During the COVID-19 Pandemic: Face-to-face

Interview Findings. PsyArXiv. https://doi.org/10.31234/osf.io/nfr5m

Islam, S. M. D.-U., Bodrud-Doza, Md., Khan, R. M., Haque, Md. A., & Mamun, M. A. (2020).

Exploring COVID-19 stress and its factors in Bangladesh: A perception-based study.

Heliyon, *6*(7), e04399. https://doi.org/10.1016/j.heliyon.2020.e04399

Ivers, L. C., & Cullen, K. A. (2011). Food insecurity: Special considerations for women. *The*

American Journal of Clinical Nutrition, *94*(6).

https://academic.oup.com/ajcn/article/94/6/1740S/4598224?login=true

Joshi, A., Arora, A., Amadi-Mgbenka, C., Mittal, N., Sharma, S., Malhotra, B., Grover, A., Misra,

A., & Loomba, M. (2019). Burden of household food insecurity in urban slum settings.

PLOS ONE, *14*(4), e0214461. https://doi.org/10.1371/journal.pone.0214461

Kangmennaang, J., Bisung, E., & Elliott, S. J. (2020). 'We Are Drinking Diseases': Perception of

Water Insecurity and Emotional Distress in Urban Slums in Accra, Ghana. *International*

Journal of Environmental Research and Public Health, *17*(3), 890.

https://doi.org/10.3390/ijerph17030890

Khan, A. M., & Flora, M. S. (2017). Maternal common mental disorders and associated factors:

A cross-sectional study in an urban slum area of Dhaka, Bangladesh. *International
Journal of Mental Health Systems*, *11*(1), 23. https://doi.org/10.1186/s13033-017-0129-
3

Kimani-Murage, E. W., Muthuri, S. K., Oti, S. O., Mutua, M. K., van de Vijver, S., & Kyobutungi, C.
(2015). Evidence of a Double Burden of Malnutrition in Urban Poor Settings in Nairobi,
Kenya. *PLoS ONE*, *10*(6), e0129943. https://doi.org/10.1371/journal.pone.0129943

Kola, L., Kohrt, B. A., Hanlon, C., Naslund, J. A., Sikander, S., Balaji, M., Benjet, C., Cheung, E. Y.
L., Eaton, J., Gonsalves, P., Hailemariam, M., Luitel, N. P., Machado, D. B., Misganaw, E.,
Omigbodun, O., Roberts, T., Salisbury, T. T., Shidhaye, R., Sunkel, C., … Patel, V. (2021).
COVID-19 mental health impact and responses in low-income and middle-income
countries: Reimagining global mental health. *The Lancet Psychiatry*, *8*(6), 535–550.
https://doi.org/10.1016/S2215-0366(21)00025-0

Leder, K., Openshaw, J. J., Allotey, P., Ansariadi, A., Barker, S. F., Burge, K., Clasen, T. F., Chown,
S. L., Duffy, G. A., Faber, P. A., Fleming, G., Forbes, A. B., French, M., Greening, C., Henry,
R., Higginson, E., Johnston, D. W., Lappan, R., Lin, A., … Brown, R. (2021). Study design,
rationale and methods of the Revitalising Informal Settlements and their Environments
(RISE) study: A cluster randomised controlled trial to evaluate environmental and
human health impacts of a water-sensitive intervention in informal settlements in
Indonesia and Fiji. *BMJ Open*, *11*(1), e042850. https://doi.org/10.1136/bmjopen-2020-
042850

Logie, C. H., Berry, I., Okumu, M., Loutet, M., McNamee, C., Hakiza, R., Musoke, D. K., Mwima,

    S., Kyambadde, P., & Mbuagbaw, L. (2022). The prevalence and correlates of depression

    before and after the COVID-19 pandemic declaration among urban refugee adolescents

    and youth in informal settlements in Kampala, Uganda: A longitudinal cohort study.

    Annals of Epidemiology, *66*, 37–43. https://doi.org/10.1016/j.annepidem.2021.11.005

Logie, C. H., Okumu, M., Mwima, S., Hakiza, R., Chemutai, D., & Kyambadde, P. (2020).

    Contextual factors associated with depression among urban refugee and displaced

    youth in Kampala, Uganda: Findings from a cross-sectional study. *Conflict and Health*,

    14(1), 45. https://doi.org/10.1186/s13031-020-00289-7

Lund, C., Breen, A., Flisher, A. J., Kakuma, R., Corrigall, J., Joska, J. A., Swartz, L., & Patel, V.

    (2010). Poverty and common mental disorders in low and middle income countries:

    A systematic review. *Social Science & Medicine*, *71*(3), 517–528.

    https://doi.org/10.1016/j.socscimed.2010.04.027

Mackinnon, A., McCallum, J., Andrews, G., & Anderson, I. (1998). The Center for

    Epidemiological Studies Depression Scale in Older Community Samples in Indonesia,

    North Korea, Myanmar, Sri Lanka, and Thailand. *The Journals of Gerontology: Series B*,

    53B(6), P343–P352. https://doi.org/10.1093/geronb/53B.6.P343

Madzorera, I., & Fawzi, W. (2020). Women empowerment is central to addressing the double

    burden of malnutrition. *EClinicalMedicine*, *20*.

    https://doi.org/10.1016/j.eclinm.2020.100286

Makassar climate: Average Temperature, weather by month, Makassar water temperature —

   Climate-Data.org. (n.d.). Climate-Data.Org. Retrieved February 16, 2022, from

   https://en.climate-data.org/asia/indonesia/south-sulawesi/makassar-3646/

Marais, L., Sharp, C., Pappin, M., Lenka, M., Cloete, J., Skinner, D., & Serekoane, J. (2013).

   Housing conditions and mental health of orphans in South Africa. *Health & Place*, *24*,

   23–29. https://doi.org/10.1016/j.healthplace.2013.08.004

Maynard, M., Andrade, L., Packull-McCormick, S., Perlman, C. M., Leos-Toro, C., & Kirkpatrick, S.

   I. (2018). Food Insecurity and Mental Health among Females in High-Income Countries.

   International Journal of Environmental Research and Public Health, *15*(7), 1424.

   https://doi.org/10.3390/ijerph15071424

McNeish, D., & Stapleton, L. M. (2016). Modeling Clustered Data with Very Few Clusters.

   Multivariate Behavioral Research, *51*(4), 495–518.

   https://doi.org/10.1080/00273171.2016.1167008

Miller, J. D., Frongillo, E. A., Weke, E., Burger, R., Wekesa, P., Sheira, L. A., Mocello, A. R., Bukusi,

   E. A., Otieno, P., Cohen, C. R., Weiser, S. D., & Young, S. L. (2021). Household Water and

   Food Insecurity Are Positively Associated with Poor Mental and Physical Health among

   Adults Living with HIV in Western Kenya. *The Journal of Nutrition*, *151*(6), 1656–1664.

   https://doi.org/10.1093/jn/nxab030

Miller, J. D., Workman, C. L., Panchang, S. V., Sneegas, G., Adams, E. A., Young, S. L., &

   Thompson, A. L. (2021). Water Security and Nutrition: Current Knowledge and Research

   Opportunities. *Advances in Nutrition (Bethesda, Md.)*, *12*(6), 2525–2539.

   https://doi.org/10.1093/advances/nmab075

Morgner, C., Ambole, A., Anditi, C., & Githira, D. (2020). Exploring the Dynamics of Social

Networks in Urban Informal Settlements: The Case of Mathare Valley, Kenya. *Urban

Forum*, *31*(4), 489–512. https://doi.org/10.1007/s12132-020-09389-2

Naghavi, M. (2019). Global, regional, and national burden of suicide mortality 1990 to 2016:

Systematic analysis for the Global Burden of Disease Study 2016. *BMJ*, *364*, l94.

https://doi.org/10.1136/bmj.l94

Naicker, N., Mathee, A., & Teare, J. (2015). Food insecurity in households in informal

settlements in urban South Africa. *South African Medical Journal*, *105*(4), 268–270.

Nickanor, N. M. (2014). *Food deserts and household food insecurity in the informal settlements

of Windhoek, Namibia*. https://open.uct.ac.za/handle/11427/9297

Nyashanu, M., Simbanegavi, P., & Gibson, L. (2020). Exploring the impact of COVID-19

pandemic lockdown on informal settlements in Tshwane Gauteng Province, South

Africa. *Global Public Health*, *15*(10), 1443–1453.

https://doi.org/10.1080/17441692.2020.1805787

Oldewage-Theron, W., & Kruger, R. (2011). Dietary diversity and adequacy of women caregivers

in a peri-urban informal settlement in South Africa. *Nutrition*, *27*(4), 420–427.

https://doi.org/10.1016/j.nut.2010.05.013

Packett, E., Grigg, N. J., Wu, J., Cuddy, S. M., Wallbrink, P. J., & Jakeman, A. J. (2020).

Mainstreaming gender into water management modelling processes. *Environmental

Modelling & Software*, *127*, 104683. https://doi.org/10.1016/j.envsoft.2020.104683

Palit, A., Batabyal, P., Kanungo, S., & Sur, D. (2012). In-house contamination of potable water in

urban slum of Kolkata, India: A possible transmission route of diarrhea. *Water Science*

and Technology, *66*(2), 299–303. https://doi.org/10.2166/wst.2012.177

Patel, V., Chisholm, D., Parikh, R., Charlson, F. J., Degenhardt, L., Dua, T., Ferrari, A. J., Hyman,

S., Laxminarayan, R., Levin, C., Lund, C., Mora, M. E. M., Petersen, I., Scott, J., Shidhaye,

R., Vijayakumar, L., Thornicroft, G., & Whiteford, H. (2016). Addressing the burden of

mental, neurological, and substance use disorders: Key messages from Disease Control

Priorities, 3rd edition. *The Lancet*, *387*(10028), 1672–1685.

https://doi.org/10.1016/S0140-6736(15)00390-6

Porter, C., Favara, M., Hittmeyer, A., Scott, D., Jiménez, A. S., Ellanki, R., Woldehanna, T., Duc, L.

T., Craske, M. G., & Stein, A. (2021). Impact of the COVID-19 pandemic on anxiety and

depression symptoms of young people in the global south: Evidence from a four-country

cohort study. *BMJ Open*, *11*(4), e049653. https://doi.org/10.1136/bmjopen-2021-

049653

Poulsen, M. N., McNab, P. R., Clayton, M. L., & Neff, R. A. (2015). A systematic review of urban

agriculture and food security impacts in low-income countries. *Food Policy*, *55*, 131–146.

https://doi.org/10.1016/j.foodpol.2015.07.002

Pouramin, P., Nagabhatla, N., & Miletto, M. (2020). A Systematic Review of Water and Gender

Interlinkages: Assessing the Intersection With Health. *Frontiers in Water*, *2*, 6.

https://doi.org/10.3389/frwa.2020.00006

Pourmotabbed, A., Moradi, S., Babaei, A., Ghavami, A., Mohammadi, H., Jalili, C., Symonds, M.

E., & Miraghajani, M. (2020). Food insecurity and mental health: A systematic review

and meta-analysis. *Public Health Nutrition*, *23*(10), 1778–1790.

https://doi.org/10.1017/S136898001900435X

Radloff, L. S. (1977). The CES-D Scale: A Self-Report Depression Scale for Research in the

General Population. *Applied Psychological Measurement*, *1*(3), 385–401.

https://doi.org/10.1177/014662167700100306

Rahmi, D. H., Wibisono, B. H., & Setiawan, B. (2001). Rukun and Gotong Royong: Managing

Public Places in an Indonesian Kampung. In P. Miao (Ed.), *Public Places in Asia Pacific*

Cities: Current Issues and Strategies (pp. 119–134). Springer Netherlands.

https://doi.org/10.1007/978-94-017-2815-7_6

Rani, D., Singh, J. K., Acharya, D., Paudel, R., Lee, K., & Singh, S. P. (2018). Household Food

Insecurity and Mental Health Among Teenage Girls Living in Urban Slums in Varanasi,

India: A Cross-Sectional Study. *International Journal of Environmental Research and*

Public Health, *15*(8), 1585. https://doi.org/10.3390/ijerph15081585

Ray, I. (2007). Women, Water, and Development. *Annual Review of Environment and Resources*,

32(1), 421–449. https://doi.org/10.1146/annurev.energy.32.041806.143704

Ringler, C., Choufani, J., Chase, C., Mekonnen, D., Dickens, C., & Mateo-Sagasta, J. (2018).

Meeting the nutrition and water targets of the Sustainable Development Goals:

Achieving progress through linked interventions. *International Water Management*

Institute (IWMI). https://www.iwmi.cgiar.org/publications/other-publication-

types/books-monographs/iwmi-jointly-published/research-for-development-learning-

series-issue-7/

Ringler, C., & Paulo, D. (2020). *Water and nutrition: Harmonizing actions for the United Nations Decade of Action on Nutrition and the United Nations Water Action Decade.* UNSCN. https://www.unscn.org/uploads/web/news/document/Water-Paper-EN-WEB-12feb.pdf

Santana, C. L. A., Manfrinato, C. V., Souza, P. R. P., Marino, A., Condé, V. F., Stedefeldt, E., Tomita, L. Y., & do Carmo Franco, M. (2021). Psychological distress, low-income, and socio-economic vulnerability in the COVID-19 pandemic. *Public Health*, *199*, 42–45. https://doi.org/10.1016/j.puhe.2021.08.016

Santomauro, D. F., Herrera, A. M. M., Shadid, J., Zheng, P., Ashbaugh, C., Pigott, D. M., Abbafati, C., Adolph, C., Amlag, J. O., Aravkin, A. Y., Bang-Jensen, B. L., Bertolacci, G. J., Bloom, S. S., Castellano, R., Castro, E., Chakrabarti, S., Chattopadhyay, J., Cogen, R. M., Collins, J. K., … Ferrari, A. J. (2021). Global prevalence and burden of depressive and anxiety disorders in 204 countries and territories in 2020 due to the COVID-19 pandemic. *The Lancet*, *0*(0). https://doi.org/10.1016/S0140-6736(21)02143-7

Sarkar, R., Sivarathinaswamy, P., Thangaraj, B., Sindhu, K. N. C., Ajjampur, S. S. R., Muliyil, J., Balraj, V., Naumova, E. N., Ward, H., & Kang, G. (2013). Burden of childhood diseases and malnutrition in a semi-urban slum in southern India. *BMC Public Health*, *13*(1), 87. https://doi.org/10.1186/1471-2458-13-87

Schuster, R. C., Butler, M. S., Wutich, A., Miller, J. D., Young, S. L., & Network (HWISE-RCN), H. W. I. E.-R. C. (2020). "If there is no water, we cannot feed our children": The far-reaching consequences of water insecurity on infant feeding practices and infant health across 16 low- and middle-income countries. *American Journal of Human Biology*, *32*(1), e23357. https://doi.org/10.1002/ajhb.23357

Serafini, G., Parmigiani, B., Amerio, A., Aguglia, A., Sher, L., & Amore, M. (2020). The

psychological impact of COVID-19 on the mental health in the general population. *QJM:

An International Journal of Medicine*, *113*(8), 531–537.

https://doi.org/10.1093/qjmed/hcaa201

Simarmata, H. A. (2017). *Phenomenology in Adaptation Planning: An Empirical Study of Flood-

affected People in Kampung Muara Baru Jakarta*. Springer.

Singh, C., Jain, G., Sukhwani, V., & Shaw, R. (2021). Losses and damages associated with slow-

onset events: Urban drought and water insecurity in Asia. *Current Opinion in

Environmental Sustainability*, *50*, 72–86. https://doi.org/10.1016/j.cosust.2021.02.006

Subbaraman, R., Nolan, L. B., Shitole, T., Sawant, K., Shitole, S., Sood, K., Nanarkar, M.,

Ghannam, J., Bloom, D. E., & Patil-Deshmukh, A. (2014). The psychological toll of slum

living—An assessment of mental health, disability, and slum-related adversities in

Mumbai, India. *The Lancet Global Health*, *2*, S26. https://doi.org/10.1016/S2214-

109X(15)70048-3

Sultana, F. (2009). Fluid lives: Subjectivities, gender and water in rural Bangladesh. *Gender,

Place & Culture*, *16*(4), 427–444. https://doi.org/10.1080/09663690903003942

Sverdlik, A. (2011). Ill-health and poverty: A literature review on health in informal settlements.

Environment and Urbanization, *23*(1), 123–155.

https://doi.org/10.1177/0956247811398604

Sweetman, C., & Medland, L. (2017). Introduction: Gender and water, sanitation and hygiene.

Gender & Development, *25*(2), 153–166.

https://doi.org/10.1080/13552074.2017.1349867

Tampubolon, G., & Hanandita, W. (2014). Poverty and mental health in Indonesia. *Social Science & Medicine*, *106*, 20–27. https://doi.org/10.1016/j.socscimed.2014.01.012

The Sustainable Development Goals Report 2021. (2021). The United Nations. https://unstats.un.org/sdgs/report/2021/The-Sustainable-Development-Goals-Report-2021.pdf

UN (United Nations) General Assembly. (2015). *Resolution adopted by the General Assembly on 25 September 2015—Sustaining our World: The 2030 Agenda for Sustainable Development*. https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf

UN-Habitat. (2015). *Informal Settlements* (No. 22; Habitat III Issue Papers). United Nations Conference on Housing and Sustainable Urban Development.

UNICEF. (2020a). *Indonesia COVID-19 Situation Report: July 15-August 12, 2020*. UNICEF. https://www.unicef.org/media/81131/file/Indonesia-COVID19-SitRep-12-Aug-2020.pdf

UNICEF. (2020b). *Indonesia COVID-19 Situation Report: 13 August—09 September 2020*. UNICEF. https://www.unicef.org/media/82856/file/Indonesia-COVID19-SitRep-9-September-2020.pdf

United Nations. (2021). *SDG Monitoring Data Set: Indicator 11.1.1: Proportion of urban population living in slums (percent)*. https://www.sdg.org/datasets/indicator-11-1-1-proportion-of-urban-population-living-in-slums-percent-6

VanderWeele, T. J. (2019). Principles of confounder selection. *European Journal of Epidemiology*, *34*(3), 211–219. https://doi.org/10.1007/s10654-019-00494-6

Varis, O., Keskinen, M., & Kummu, M. (2017). Four dimensions of water security with a case of
the indirect role of water in global food security. *Water Security*, *1*, 36–45.
https://doi.org/10.1016/j.wasec.2017.06.002

WHO Indonesia. (2020). *Coronavirus Disease 2019 (COVID-19) Situation Report* (No. 22). WHO
Indonesia. https://cdn.who.int/media/docs/default-source/searo/indonesia/external-
situation-report-22-26-aug2020.pdf?sfvrsn=c1013c5b_2

Winter, J. C., Darmstadt, G. L., & Davis, J. (2021). The role of piped water supplies in advancing
health, economic development, and gender equality in rural communities. *Social Science
& Medicine*, *270*, 113599. https://doi.org/10.1016/j.socscimed.2020.113599

World Health Organization, UN-Habitat. (2016). *Global Report on Urban Health: Equitable,
Healthier Cities for Sustainable Development*.

Wutich, A., Brewis, A., & Tsai, A. (2020). Water and mental health. *WIREs Water*, *7*(5), e1461.
https://doi.org/10.1002/wat2.1461

Wutich, A., & Ragsdale, K. (2008). Water insecurity and emotional distress: Coping with supply,
access, and seasonal variability of water in a Bolivian squatter settlement. *Social Science
& Medicine*, *67*(12), 2116–2125. https://doi.org/10.1016/j.socscimed.2008.09.042

Young, S. L., Frongillo, E. A., Jamaluddine, Z., Melgar-Quiñonez, H., Pérez-Escamilla, R., Ringler,
C., & Rosinger, A. Y. (2021). Perspective: The Importance of Water Security for Ensuring
Food Security, Good Nutrition, and Well-being. *Advances in Nutrition*, *12*(4), 1058–1073.
https://doi.org/10.1093/advances/nmab003

Young, S. L., Miller, J. D., Frongillo, E. A., Boateng, G. O., Jamaluddine, Z., & Neilands, T. B.
(2021). Validity of a Four-Item Household Water Insecurity Experiences Scale for

Assessing Water Issues Related to Health and Well-Being. *The American Journal of Tropical Medicine and Hygiene*, *104*(1), 391–394. https://doi.org/10.4269/ajtmh.20-0417

Zakerhaghighi, K., Khanian, M., & Gheitarani, N. (2015). Subjective Quality of Life; Assessment of Residents of Informal Settlements in Iran (A Case Study of Hesar Imam Khomeini, Hamedan). *Applied Research in Quality of Life*, *10*(3), 419–434. https://doi.org/10.1007/s11482-014-9320-8